IONOSPHERIC NETWORK ADVISORY GROUP (INAG)*

Ionosphere Station Information Bulletin No. 27 **

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* Under the auspices of Commission G Working Group G.1 of the International Union of Radio Science (URSI).

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I. Introduction

by

W. R. Piggott, Chairman

This issue of the INAG Bulletin is mainly concerned with the Report of the INAG meeting at Geneva, January 5-6, 1978, together with some of the papers presented to it. The remainder will be published in the next issue. I must apologize to those whose articles are delayed, the work involved in preparing the Report and revising the published articles has occupied all the time available if this issue is to be published quickly.

The last opportunity to comment on the IAGA/URSI Report "Needs for Ionosondes in the 1980's will be at the INAG meeting at Helsinki during the General Assembly of URSI, August 1-16, 1978, (p.). *If you wish to influence the comments INAG will make at Helsinki on this report, please inform the Chairman as soon as possible or at the latest, inform your country's representative on Commission G of your views so that he can make them known at Helsinki.* Controversial points or points where you need support from other people should be published in the next INAG Bulletin, which will probably be the last before Helsinki. *This is only possible if you reply immediately.*

INAG wishes to make decisions at Helsinki on (a) whether a training handbook is really necessary, (b) whether there should be any changes in the parameters to be circulated internationally, and (c) whether any letter symbols should be omitted or simplified. It would be useful to know which stations are likely to continue after the IMS, though some Administrations may prefer to wait until they have received the official views of IAGA, URSI, COSPAR, CCIR, and INAG before deciding this point. It is already clear that there is wide support for the continuation of an important VI network.

I wish to draw attention of all INAG members and any others interested to the request for suggestions for new sites for ionosondes or for the reopening at selected closed stations. This is recommended in the IAGA/URSI Report. It now appears possible that new sources of ionosondes will be available by the time any suggestions have been properly examined scientifically and accepted by a sponsoring body. Thus the effort should not be wasted.

It became clear at Geneva that many people could not attend INAG meetings unless they were informed at least 18 months in advance. We intend in the future to hold such meetings in conjunction with all URSI General Assemblies (3-year intervals), IAGA Assemblies (2-year intervals), and hope to arrange meetings in Geneva in conjunction with CCIR at roughly 2-yearly intervals. INAG members arranging regional meetings should note the long lead time and make at least a preliminary announcement well in advance.

I feel that the first INAG meeting of 1978 has been very useful and that the New Year may show an appreciable change in the fortunes and future of the vertical incidence network. On behalf of INAG, we wish you a Very Happy and Prosperous New Year.

II. Report of the INAG Meeting, Geneva, January 5-6, 1978

Participants:

W. R. Piggott, Chairman	U.K.
J. Virginia Lincoln, Secretary	U.S.A.
Y. Hakura, representing I. Kasuya	Japan
C. G. McCue, representing D.G. Cole	Australia
G. M. Pillet, Member	France
J. R. Dudeney, Alternate	U.K.
Y. Otaki	CCIR
T. Turunen	Finland
R. Hanbaba	France

1. Chairman's Introduction

(a) Introduction

The Chairman welcomed the participants, noted that five INAG members were represented, and introduced Dr. Y. Otaki, who was representing the CCIR at the meeting. The main objects of the meeting were to consider the recommendations of the informal INAG meetings at Boulder, Cambridge and IAGA, and action to be taken on the IAGA/URSI report on the future of the network, with special stress on problems which were of direct interest to the CCIR.

(b) Vote of Thanks

The INAG Working Group thanked Mr. R. C. Kirby, Director of CCIR, for making the room available for the 2 days and requested that these thanks be forwarded to him.

The INAG Working Group, on behalf of the vertical incidence network, thanked the Japanese, Russian and Argentine groups who had organized the translation of the High Latitude Supplement into Japanese, Russian and Spanish, respectively, and requested that their thanks and appreciation for this large effort be conveyed to those involved in the translation process.

(c) CCIR Cooperation

It was agreed that the representatives who were attending the CCIR meetings would act as a link between the CCIR Working Groups and INAG and would draw the attention of INAG to CCIR requirements. They would also bring problems raised by INAG in this meeting to the attention of the appropriate working group.

(d) INAG Meetings

Several members drew attention to the difficulty of obtaining money for INAG members to attend INAG meetings. In some countries, the lead time could be as much as two years since the financial year differed from country to country.

The meeting recommended that meetings held in conjunction with URSI General Assemblies, IAGA and CCIR should be made formal meetings of INAG, and that preliminary notification of these meetings should be made whenever possible at least 18 months in advance. Preliminary agenda for the meetings should be published at the time of the announcement so as to draw attention to the main subjects for discussion. The meeting endorsed the suggestion that INAG advertise its meetings and problems more widely, e.g., in the URSI Information Bulletin, IAGA News and IMS Newsletter.

The Australians felt that national representatives of URSI Commission G should be informed of all future formal INAG meetings held in conjunction with international meetings so that they could collect information of interest to INAG and brief the person who would be attending the meeting. This was agreed.

INAG wishes to encourage more ad hoc meetings and felt that the INAG members should promote local INAG meetings in their own region and encourage those operating stations in the region to send representatives so that local problems could be discussed and brought to the attention of INAG.

As it is important for INAG to obtain views from as wide an audience as possible, and is therefore worthwhile raising the same problems at a number of different meetings, *it was agreed that the Chairman should write to the organizers of ASHAY and request that an informal INAG meeting be held in conjunction with the ASHAY meeting, at Alpbach, Austria, May 24-June 10, 1978.*

(e) Brisbane - History of Scaling Changes

A history of scaling changes has been made for the Brisbane station. The dates of scaling changes and any local interpretation of rules have been recorded. Similar records are being collected for other Australian stations and a number of reports will be sent to INAG in due course. The meeting congratulated Mr. McCue on the Australian initiative and stressed the importance to the scientists of repeating these exercises at least at the stations with longer series of observations. Changes in scaling procedures are liable to change parameters and thus mislead the user.

2. IAGA/URSI Report "Needs for Ionosondes in the 1980's"

(a) General Discussion

The Chairman pointed out that the report (INAG 26, pp. 7-14) had been prepared by scientists with relatively little input from INAG since it was felt that the report would carry more weight if it represented the views of the users of the data rather than those who produce it. However, INAG could make comments on the report when it was considered by URSI at the URSI General Assembly.

Dr. Dudeney then introduced the report and stressed the importance of the criteria for identifying stations that are especially valuable (INAG 26, p. 14, para. 74). He outlined the objections raised by Professor Rawer at IAGA who felt that the report was rather negative, particularly from the point of view of groups who were using local networks for special research. A letter from Dr. Bossy, which arrived too late to be included in INAG 26, will be found on page 16 of INAG 27.

Mr. McCue commented that it was not the intention of the working group to construct a crutch for existing stations nor to supply an excuse for closing any stations. It was set up to study the needs in the 1980's for a MINIMUM network operating ROUTINELY on a GLOBAL SCALE. It was envisaged that smaller scale networks would and should exist within the global scheme. These would operate to satisfy particular purposes, e.g., special experiments and national requirements for communications and defense. This was an 'anchor' report meant to hold firm the essential world network of ionosondes against further closures. In the event it went further than that in advocating that ionosonde data should be supported and supplemented by other instruments routinely operated at the ionosonde sites, and by the opening of some new stations.

INAG should decide whether or not to endorse the Report at the URSI General Assembly in Helsinki. It can only take into account comments received before or at this Assembly. *Act now if you wish to influence the decision.*

Dr. Hakura stated that the Japanese view was as follows:

At least a minimum number of ionosondes spread to give worldwide coverage is necessary for the monitoring of the Earth's environment. Long sequences of observations of the ionosphere on a routine basis makes it possible to obtain better understanding of the secular variation of the ionized atmosphere.

In this connection, it is desirable to have some additional ionospheric stations in certain areas of the globe. It might be possible to cover the ocean area using unattended ionosondes which would automatically measure, scale and send ionospheric parameters in digital form, via a space station like French satellite ARGOS.

Denser observation network is necessary for the regions of special interest, such as the polar region, the equatorial region, and the anomalously particle-precipitating regions. Syowa station in Antarctica will be maintained because of the high priority of polar studies in Japan.

(b) <u>CCIR Requirements</u>

The Chairman pointed out that CCIR requirements were only mentioned in para. 14 (loc sit. p. 12) and needed further consideration. A considerable discussion on these requirements then followed, the following points being stressed:

(i) While traditional services can probably be met adequately by para. 14, many current CCIR problems involve data which do not at present exist, including probably a different stress on routine ionospheric data.

(ii) The use of HF by small organizations, particularly those concerned with mobile circuits, or in developing countries, appears to have increased, the loss of the traditional high power point-to-point services has not, in practice, decreased the congestion in the HF bands.

(iii) HF is particularly important for safety at sea, and on occasions of natural disasters.

(iv) There is widespread defense interest in HF communications in all countries.

(v) There was a growing interest in real-time observations, particularly for short-term forecasts.

Some doubts were expressed on the value in practice of data from extra equipment, e.g., oblique sounders (para. 14), mainly because the technical support needed was seldom available for complex equipments to be operated effectively. Simple equipments involve difficult, and often unsolvable interpretation problems. Although there had been as many as 90 oblique HF circuits at the same time, little of the data appear to have been effective in improving communications.

The main CCIR document on this subject was "Opinion 22-2". This was being considered at the current meeting and would probably be approved in June. After approval, it would form part of the case to be sent to Administrations.

(c) <u>Local and Regional Requirements</u>

The Chairman pointed out that many existing stations were primarily set up for local reasons, either scientific, practical or mixed. Such reasons could not be included in the general analysis but should be taken into account when Administrations were proposing to open or close stations. Similarly the special needs for regional studies must be identified and justified by the specialist groups involved. Dr. Bossy had acted for one such group. Are there any others? Do the high- and low-latitude experts feel that the recommended network will be adequate for their purposes?

The Chairman also drew attention to the COSPAR statement on the network needed for space research, reproduced on page 16.

The Secretary pointed out that this decision was produced by experts who had no direct contact with the V.I. network or INAG.

(d) Gap-Filling in Network

The IAGA/URSI report draws attention to the need for additional stations in certain areas (loc sit. p. 11, para. 11) and INAG has previously been requested to make comments on whether certain stations which have been closed should be reopened, if and when equipment becomes available (INAG 23, p. 6).

Up to the present the old age of existing equipments and the shortage of new ionosondes has prevented any significant extension of the network. However, this situation is likely to change in the next few years. It is therefore now worthwhile to reconsider priorities for opening new or closed stations. This involves considerable analysis and planning. The meeting decided to ask all INAG members to review potential network sites in their theaters and requested the Chairman to draw the attention of specialized scientific conferences to the need to make recommendations. For example, these should be considered at the ASHAY meeting.

(e) Action on Report

INAG should collect all comments on the report and present them to URSI when the Report was considered by Commission G.

It was felt that the recommendations of the joint IAGA/URSI Working Group together with recommendations of COSPAR, IAGA and URSI should be brought to the attention of the Administrations responsible for the network after the document had been approved by URSI.

It might be worthwhile to follow this with another administration meeting similar to that held under STP auspices in 1969, if the Administrations so desired. However, such a meeting needed much preparation work which would probably require a year. *In the meantime, there are a number of urgent problems on which INAG needs information. These could best be overcome by sending a short questionnaire to station Administrations and acting on the advice of those who replied.*

3. Status of Networks

The comments below supplement those already published in INAG 25, pp. 3-4, and INAG 26, pp. 2-4.

(a) Reports of Participants

(i) Australia

The Townsville sounder has moved 50 km due south from its old site in September, 1977. The new site (19°38'S,146°51.5E) accommodates a Granger oblique ionospheric sounder for monitoring the circuits between Townsville and Okinawa, and Townsville to Adelaide. The following stations of the Australian network are now equipped with Australian 4A ionosondes: Casey, Mawson, Hobart, Canberra, Norfolk Is., Townsville and Vanimo. The ionograms are now recorded on 16 mm film (see report on 4A ionosonde, page 19). A highly directional antenna system has been built at Mawson to operate with the 4A ionosonde. This enables direction of the arrival of echoes to be monitored. The directional ionosonde is not operated synoptically.

An Australian 4A ionosonde has been acquired by Ibadan, and a similar equipment has been made available to NOAA as a possible solution for the NOAA requirements for cheap observatory style ionosondes.

A 4A ionosonde has been supplied to Port Moresby as a gift from the Australian Government for the Government of Papua, New Guinea. This ionosonde will be operated on a synoptic program by Professor Carmen of the Department of Physics.

(ii) Japan

Dr. Hakura reported that Wakkanai, Akita, Tokyo, Yamagawa and Okinawa (reopened in February 1977), and Syowa are in operation and expected to continue after the IMS. He also stated that three new digital ionosondes had been constructed and deployed at Japanese stations and eventually all Japanese stations would be equipped with these instruments.

(iii) U.K.

Dr. Dudeney stressed that Port Stanley would close at the end of 1979 unless there was a sufficient demand from the international community to the contrary. It was hoped that an advanced ionospheric sounding equipment of the NOAA type would be obtained to enable research to be expanded in Antarctica. If this occurred, the station at South Georgia will be closed at the end of 1978 or 1979 to provide additional manpower and money for the research program. The Australian 4A ionosonde was now at South Georgia. Detailed discussions with Mr. McCue showed that the difficulties with this ionosonde were probably mainly due to its being a prototype, later versions had given no trouble. Modifications to bring this up to date would be provided as soon as possible. Slough will continue to operate after the IMS.

(iv) U.S.A.

Data are now being received from the station at Patrick Air Force Base. It is hoped to put an ionosonde at Siple (Antarctica) in the future. If money becomes available, NOAA will need to replace some 40 existing ionosondes to maintain their network.

(v) General

The Chairman drew attention to the need for cheap ionosondes for use in developing countries and felt that probably around 60 might be needed within the next 5 years. Some of these might prefer less simple equipment, e.g., the class of the IS-14, chirp or SHISG ionosondes.

(vi) Conjugate Stations

Dr. Dudeney drew attention to the importance of the stations at Wallops Island and St. Johns, Newfoundland, for conjugate studies. These stations are conjugate to the BAS stations at Argentine Islands and Halley Bay, respectively.

(b) Action on Proposed Closures

(i) Port Stanley

Anyone wishing to use future data from Port Stanley should make a case for the continuance of this station to the Director, Appleton Laboratory, Ditton Park, Slough SL3 9JX, U.K.

(ii) It is likely that the future of the *Canadian network* will be reviewed at the end of the IMS. *Those wishing for any stations to continue should make their needs known to INAG.*

(iii) INAG proposed to circulate to all Administrations a questionnaire asking:

(a) which stations will definitely continue after the IMS?
(b) for which stations there are definite proposals to close?
(c) the stations whose future is at present unknown?

(iv) INAG representatives at CCIR will note CCIR requirements and report.

(c) Status of New Ionosondes

Dr. Turunen reviewed the development of the new Finnish ionosonde IS-14 and its operation at Sodankyla (see New Ionosondes, p. 18). This equipment is now being produced commercially and copies of the specifications can be obtained from INAG, and from the manufacturers. Mr. McCue reported on the development of the Australian 4A ionosonde (see p. 19) since the previous report at Lima. He was planning further development involving microprocessor control, storage of data at remote sites, and possibly transmission of data from outstations.

Mr. McCue reported that an 8-element interferometer had been built for Queensland University at Bribie Island (27°S, 153.2°E) where the phase ionosonde was working very successfully (see article, p. 28). At Hobart, Professor Ellis has a highly directive antenna operating over 1-20 MHz. When this is in use, spread-F disappears. Similar equipment on much higher frequencies has been used to localize solar noise bursts and noise bursts from Jupiter.

In reply to Mr. McCue, the Chairman stated that the UK development of a cheap Chirp ionosonde had ceased owing to lack of suitable technical staff.

(d) Computer Aids to Data Analysis

Dr. Dudeney then described the micro-processor and printer system developed by the British Antarctic Survey stressing that this equipment was intended primarily for field use in Antarctica.

The ionograms were analyzed as usual using a light table but the parameters were entered through a keyboard to a micro-processor and printer. This requests each parameter in turn to only accept data in the form laid down by the Handbook and checks for internal consistency, giving an error message when this fails. At present, the 30 most important INAG rules are included in the instructions and there is sufficient core to enable usable medians to be produced in the field. The corrected output is produced as a daily worksheet and in paper tape or magnetic tape form. The cost of the equipment is about U.S. $3K and circuit details will be available from BAS. A report will be written for the INAG Bulletin in the near future. It is still the intention to feed raw data into the large computer in U.K. for publication and research purposes.

There was considerable discussion on the modification needed to allow direct scaling from a projected ionogram using a cursor table or a light pen. Dr. Dudeney pointed out that this would be a much more complex and expensive equipment, not suitable or desirable for field use, but that modern developments would probably make it relatively simple and cheap in the near future. This type of operation is in use at several centers.

4. Handbook and High Latitude Supplement

(a) Status and Translations

The Chairman announced that the High Latitude Supplement had been translated into Russian by T. I. Shchuka. Unfortunately, the correspondence giving this information had gone astray and it had only recently come to his attention. As mentioned in the INAG Bulletin (INAG-26, p. 19), Spanish and Japanese versions had been published. The operators of the French High Latitude Stations all understand English very well so there has been no need to translate the Supplement into French.

(b) Future Plans

(i) Training Manual

The consensus of opinion appears to be that the current Handbook is very good for use by trained operators but is not so useful for training operators. This occurs because some key sentences (e.g., in the selection rules) occur in widely different parts of the Handbook to the remainder of the detailed instructions, and because the combination of basic rules and special difficult cases is confusing for a new operator to understand. There have also been many clarifications and corrections to the Handbook which make it inconvenient to use. Thus the ad hoc meetings had raised the question of whether a training manual should be prepared by re-arranging the Handbook material so as to be more useful for initial training. This would involve much work by the few qualified people available and should not be attempted unless there was a real demand. A danger of a simplified manual is that discrepancies in procedure between different groups will appear if the trainees do not proceed to the main Handbook.

Mr. McCue stated that if such a manual is seriously considered, the Australian network had the following views: It would welcome physical explanations for particular ionograms. It does not recommend the division of these phenomena into latitude zones because it discourages operators from appreciating others' problems and may cause divisive reactions within the world network. Obviously some phenomena are limited to certain geographic areas but others are better grouped under their ionogram effect. Piggott's scheme of horizontal stratification; tilted ionosphere, special phenomena; (INAG Bulletin 26) is good provided the explanation is largely based on illustrated ionograms.

Various members commented on the problems they met in training and the procedures they had adopted. The French, with highly experienced centralized analysis, had no problems. The UK give a preliminary training largely based on ionograms and line drawings of the types which have been published in INAG. After this the trainees had little difficulty with the Handbook and appreciated the detailed instructions for difficult cases. There were, however, still some points on which the Handbook did not give adequately clear instructions.

The meeting recommended that any unpublished aids of the UK type should be published in the INAG Bulletin in a new correspondence section and that other groups using local aids should be encouraged to contribute.

(ii) Reprinting of Chapters 1-4 of Handbook

The Secretary stated that WDC-A was willing to publish a revised version of Chapters 1 to 4 of the Handbook, incorporating all corrections and additions, as a Report in the UAG series. The manuscript for the final corrections and additions was available and had been agreed with the Chairman who will write a brief introduction for this Report. Work could start on typing the master manuscript as soon as the material reached Boulder and it was hoped to have the revised Report ready for the Helsinki meeting.

The meeting recommended that this proposal be accepted and that the Report be published as soon as possible.

(c) Parameters to be Scaled

(i) Policy

The ad hoc meetings had drawn attention to the desirability of reviewing the parameters recommended for interchange internationally and the meeting felt that this should be done. If changes were needed they should be fully discussed and introduced with effect from a stated date. It is confusing to make a series of small changes.

The meeting recommended that no changes in the international parameters or interchange rules should be made until, at the earliest, the end of the IMS so as to maintain consistency in IMS data as far as possible.

There was a real difficulty in forming a consensus on future parameters owing to the restricted representation available at INAG meetings. To minimize this INAG should attempt to hold more meetings and to circulate known users with a questionnaire. Where necessary, this could be biased so that a decision can be reached where the response was minimal. An attempt should be made to get a questionnaire circulated in time for the results to be considered by INAG at Helsinki. Special attention should be paid to the comments from developing countries.

(ii) Scaling Errors in Ionospheric Characteristics

The desirability of continuing to record a given parameter depends on its potential usefulness and on the amount of work needed to obtain data with adequate accuracy. Mr. McCue stated:

"The results from an IPS scaling exercise have been used to estimate and evaluate the normal accuracy with which ionospheric characteristics may be scaled and the consistency between scalers in the use of the qualifying and descriptive letters. A brief account of this has been submitted to INAG for circulation. A more detailed account will soon be published in an IPS R-series report.

"The results are only applicable to the Australian network and could be widened if other station networks repeated the exercise. The 35 mm film made for the exercise is held by WDC-A in Boulder. The analysis programs used to produce the results are available in the form of paper tape, printed output or possibly cards."

Thus it is relatively easy for any group who wish to see how their operators compare with the Australian group to repeat the exercise using the same ionograms. INAG wishes to encourage such tests.

For the standard parameters, the Australian exercise (see p. 20) showed that foEs, fxI and M(3000)F2 gave the greatest difficulties to scalers, though it was also clearly difficult to measure foE so that the median values were accurate to scaling accuracy. Es types give difficulties and their value should be examined. Some of the proposals made at the ad hoc meeting are probably unsound and due to lack of knowledge of why the rules are in their present form. The Chairman was requested to write short articles for INAG to clarify the latter point.

(iii) fxI

The addition of fxI to the standard list of international parameters had stretched some reduction teams to the limit and some decrease in the number of parameters to be circulated would be helpful.

Dr. Dudeney raised the question of whether fxI was being used sufficiently to justify the scaling effort. The Chairman pointed out that fxI had been invented originally at the request of the CCIR and that it had now been running sufficiently long to enable a proper test of its value to be made. Either CCIR or INAG should sponsor a test of the value of this parameter and CCIR should be asked whether, if data were obtained from sufficient stations, fxI would, in fact, be used in the future. INAG representatives would take this up with the proper CCIR Working Groups. He also commented that in the preliminary tests using data center ionograms, fxI appeared to be valuable for CCIR purposes. For example, at temperate latitudes in sunspot minimum years, the available frequency band at night based on fxI was roughly twice as wide as that deduced from foF2 and the ratio was only slightly less in sunspot maximum years. At high latitudes, fxI drew attention to the importance of ridges with high critical frequencies which in practice determined the MUF even when the ridge was some hundreds of kilometers away from the sounding station.

Depending on the CCIR replies and the results of the exercise, INAG should either stress the importance of measuring fxI at sufficient stations for practical purposes, or should reduce the parameter to optional status.

(iv) Es Types

It is arguable that most of the information which can be obtained using Es types is available in past published data. The continuing measurement of types should be reviewed by questionnaire and at INAG meetings with the object of finding whether they should be discontinued entirely, continued only in selected zones, or are still useful.

At the beginning of the IMS there was much stress on the importance of distinguishing cases where particle activity was present overhead from those in which it was observed obliquely. For this reason the rules for distinguishing between particle E and Es-r or between total reflecting flat and Es-a were strengthened in the Handbook and High Latitude Supplement. Automatically, of course, this means that the physical phenomenon is described differently when overhead as compared with when seen obliquely. The analysis of Es types at high latitude stations could be cut considerably by allowing these distinctions to disappear. This has been advocated by our colleagues in the USSR. Preliminary IMS work suggests that the high latitude types can be valuable for identifying magnetospheric phenomena. This theme was developed by Dr. Turunen who also submitted a long written contribution (to be published in a future Bulletin) in which the main point was that the most important distinction was between particle generated traces and those generated by temperate latitude phenomena. Es-q was also a special case, which might have continuing use.

(v) foEs

As illustrated by the Australian parameter exercise, foEs gives more trouble than most of the parameters and its significance for scientific and practical purposes is relatively limited. Most groups tend to give more attention to analyzing this parameter uniformly than is physically justified. The greatest confusion arises when a weak low type Es trace is present in a lower part of a normal E pattern. When this is seen, it is usually fairly regular so that parameters gradually give it more importance than it justifies. Originally, groups ignored this trace under the weak trace selection rule (Handbook, p. 27, sec. 2.0(c)) but in recent years some groups measure foEs from this trace when it is an Es trace extending to the highest frequency. For both physical and CCIR purposes this is unsound as the trace is due to a mechanism quite dissimilar to those which produce other types of Es trace. Experience with 2 MHz Loran signals shows that the partial reflections from the bottom of the D region are operationally far more important than the partial reflection from the steep gradient in the E layer. If the rules are reconsidered after the end of the IMS, a simple solution might be to state specifically that this type of trace should be ignored thus restricting evaluation of low Es traces to cases where fbEs for the low trace exceeded foE. At present, the world data are inconsistent because a few stations are measuring the weak trace from the E layer during the day. The South American stations are measuring foEs on one trace and fbEs on another in contradiction to the basic rule (Handbook, p. 90, sec. 4.1) whereas the remainder appear to be essentially correct.

(vi) Spread-F Types

The tabulation of spread-F types is optional and the procedure of these tabulations has not as yet been determined. It appears to cause many queries from the operators. Dr. Turunen and Dr. Dudeney reported that their groups were studying these indices and the former stated that he would try to make a report before the Helsinki meeting. WDC-A would find out how many stations are making these observations and report at Helsinki.

(vii) Special Phenomena

An investigation of the morphology of Lacuna and Slant Es has been made and will be reported in this Bulletin (p. 34). This shows that the phenomenon is quite widespread at high latitudes. Mlle. Pillet presented evidence for a real distinction between the G condition and an F2 Lacuna and stated that her staff now had no difficulty in making the distinction consistently. The presence of F2 Lacuna has a considerable effect on the median values of foF2. The evidence would be published in this INAG Bulletin. The Chairman suggested that groups who understand the differences between G condition and Lacuna should use letter Y when F2 Lacuna is present. It would be clear from the tables that this local rule was in use but if possible a note should also be added on the tabulated data sheets or Bulletins, e.g., F2 Lacuna conditions denoted by Y (INAG-9, pp. 5-10).

(d) Nature of foF1

Dr. Dudeney reported on the interpretation of foF1. In the limit case, the URSI convention implies that the true value of foF1 is greater than that observed. This work shows that it is, in fact, less. The paper can be found on p. 26. This paper shows clearly that the published values of foF1 can be misleading when this parameter is used as a measure of ion production rate in the F layer. The meaning of MUF F1 for practical purposes is clearly suspect unless the cusp is well marked and stations should be discouraged from measuring limit values of foF1 (i.e., those involving ...DL).

(e) Monitoring of the Auroral Oval

The Chairman stated that his CCOG paper on this subject had been published in INAG 26, pp. 15-19. The main difficulty in practice is due to the presence of multiple troughs, ridges and zones of particle precipitation at higher latitudes than the main auroral oval as shown originally by Muldrew from topside sounder data. It appeared that the typical signatures can be identified fairly readily. However, further action is desirable as suggested at the ad hoc meetings. Dudeney stated that BAS has used the signatures at Halley Bay to compare movements of the plasmapause trough with movements of the plasmapause shown by whistler data. These were closely correlated. Turunen pointed out that most magnetospheric phenomena show similar temporal variations and suggested that the peak in fbEs follows the plasmapause. He found that fbEs exceeded 2 MHz whenever mantle aurora was present around magnetic midnight, and Es-a was closely linked with active aurora and was blanketing to high frequencies when this was overhead. The group recommended that the Chairman select some typical examples of auroral oval signatures from the High Latitude Supplement and list these for the guidance of future users. The Chairman pointed out that for suitably placed stations, the auroral oval passed over the station at times widely separated from magnetic midnight so that local conditions were simple and the critical information was the times at which the sectors were first and last seen - a very simple reduction procedure.

(f) Digital Ionosondes

It was agreed that no attempt should be made to modify the Handbook rules for use with digital ionosondes until a clear need arises.

(g) Collection of Classical Ionograms

The group felt that the preparation of a training manual would probably prove desirable and that initial steps to make this possible should be taken. *In particular, the general agreement that classical ionograms were needed to illustrate the line drawings in the Handbook implies that the selection of such ionograms should be started as soon as possible by groups who wish to see their ionograms in the training manual.* Dr. Dudeney reported that the BAS station at Argentine Islands was already identifying suitable ionograms in the daily worksheet and that he hoped that his other stations would also do this. It is fairly difficult to find ionograms which illustrate the simple cases with no misleading special anomalies so early selection is desirable. If, for any reason, the training manual was not prepared any ionograms collected would be published in the INAG Bulletin. Groups providing ionograms should be encouraged to also provide the corresponding line drawing and table of reduced parameters wherever possible, as in the High Latitude Supplement.

5. INAG Bulletin

(a) Status

Mr. McCue stated that the operators would like to see Bulletins every 3 months if possible. There have recently been gaps of the order of 6 months. The Chairman stated that this was due to pressure of other work on him but that he hoped to improve the publication in the future. It was hoped that INAG-27, containing the report of this meeting, would be followed by INAG-28 to be issued approximately 3 months later. *The latter might be the last Bulletin before the Helsinki meeting and any comments which readers wished to have raised should, if possible, be included in this issue.* WDC-A would, if possible, update the index so that the references to work done by INAG during the 3 years could be readily identified at Helsinki.

There was some doubt as to whether all stations were receiving the Bulletins particularly those who send their data only to one WDC. Data Center practice in sending out Bulletins should be checked as soon as possible. The Chairman and Secretary would start enquiries.

(b) Future Contents

Mr. McCue stated that scaling examples in Uncle Roy's Column are greatly appreciated by the operators, both for training purposes and as arbiters in scaling discussions.

The Chairman reported that the UK training aids appear to be very popular and that a correspondence section would be added to future Bulletins giving further training aids which are available from the UK. It was hoped that this would provoke other groups to provide similar material.

The meeting felt that the reports of resolutions from international bodies which affect the vertical incidence network should continue to be published and that there was much value in publishing programs of special work. Frequently vertical incidence data were needed in support of such programs and the Bulletin provided a useful means of contacting people who might otherwise be overlooked. The Secretary stated that WDC-A was not circulating programs in a number of geophysical fields mainly in connection with IAGA or joint URSI/IAGA working groups.

The meeting recommended that the Chairman contact the Chairmen of other working groups to discover whether they wished to use the Bulletin. (Note: most current programs are listed in the IMS Newsletter which will continue to be published monthly throughout the IMS by the Special Committee on Solar Terrestrial Physics.)

(c) Finance

The INAG Bulletin is partly financed by a grant of $500 (U.S.) per year from URSI, partly from the funds of WDC-A and partly by contributions of $10 for all issues in the 3-year period between General Assemblies from those recipients who are able to obtain the necessary foreign exchange. It is sent out to all known ionospheric stations, whether they can afford to pay or not. However, both the URSI and WDC-A contributions depend on sufficient contributions being received to demonstrate that the Bulletin is useful to the ionospheric community. The arrangements will be reviewed at the URSI General Assembly at Helsinki. INAG proposes to suggest that the arrangements made at Lima be continued for another 3 years, if this can be agreed by our sponsors.

6. Training Problems

(a) Reports from Participants

(i) Australian Operators' Conference

The Australian ionospheric station operators' conference will be held at the IPS in Sydney on 24th to 26th May, 1978.

The main topics for discussion will be:

- The results of a 4A ionogram scaling exercise which will be complete by then;
- Any problems associated with 4A scaling;
- The performance of the 4A ionosonde;
- The use of existing modifications;
- Suggestions for further modification and development.

This conference is also used to discuss training problems, and, as at previous conferences, visitors from other organisations will be welcome. Details can be obtained from Dr. D.G. Cole.

(ii) UK Training Course

Dr. Dudeney stated that the annual BAS training course for Antarctic operators at the BAS bases would commence in the first week of July. The trainees have no previous ionospheric knowledge. As in the past, visitors from other organizations would be welcome provided they notify their desire to attend as soon as possible, and in any case before the beginning of June. This is necessary as such visitors can seldom stay for the whole course and their presence therefore means some modification to the training program.

(iii) Interchange and Analysis Checks on High Latitude Ionograms

Mlle. Pillet stated that Mme. Cartron wished to organize an exchange of ionograms and reductions for polar ionograms with other high latitude groups in order to discover whether different groups reduced the same ionogram in the same way. She proposed to make available one summer month of data from Terre Adelie for independent analysis by a different organization. In exchange she would like to receive 1 month of ionograms from a high latitude (polar cap or auroral zone) station for analysis by the French group. A comparison of the daily worksheets would then show points of agreement and disagreement. *INAG requests that groups willing to take part in this exercise write to Mme. Cartron* *directly at:* Laboratoire de Geophysique Externe, 4, Avenue de Neptune, 94100 Saint-Maur, France.

This proposal has had strong support from those at the meeting who felt that tests of this type are essential to make the analysis of high latitude ionograms sufficiently uniform. Previous tests on the IGY data, INAG 4, pp. 2-5, showed alarming differences. Exercises of this type were also carried out in Scandinavia in preparation for the IMS (Sodankyla, INAG-15, pp. 13-14, Uppsala, INAG-22, pp. 5-7) and showed that they were very necessary.

(iv) Dr. Turunen stated that CCOG had no plans for further ionogram interpretation meetings at present.

(v) The Secretary stated that no progress has been made on the proposed NOAA training film owing to the pressure of other work, but that some reels of standard ionograms were available which were used for local training. Some of these might be suitable for the proposed training handbook.

(b) Needs of India, Africa and Asia

It was believed that the main difficulty with the Indian chain of stations was due to poor equipment, rather than training difficulties, though the discrepancies in interpretation which have been found in data from highly developed countries suggest that it is desirable to arrange clarification meetings from time to time in all countries. The efficiency of the network could possibly best be maximized, if there was an INAG member with special experience in Indian conditions. The Chairman would write to India to explore the situation further, and report to the INAG members.

A general discussion of the problems in Africa and Asia then followed. In some cases, the Institutes in these continents are advised by institutes in more advanced countries and depended on the latter to make their needs known internationally. INAG requests such institutes to inform it on current problems.

In general, European training of operators for particular stations had not proved very successful. The prestige gained by the trainee from his course often resulted in a transfer to a job outside the station. It would probably be more effective to train more senior staff at the institutions (usually universities) so that they could train the actual operators. This was also more efficient since such staff had normally already acquired academic qualifications and were thus easier to teach. If suitable candidates could be financed to attend a special training conference held in Africa or Asia, this would probably be more economical than financing individuals to come to Europe, the USA, or other training centers. Two weeks should be adequate for university staff or people with similar qualifications, provided the teacher was adequately qualified in ionogram interpretation problems.

If this solution was adopted, the training manual should be planned to be suitable for the staff who would not normally be deeply involved in the actual ionogram reduction process.

Mr. McCue stated that the Australians had trained engineers for stations in Papua, New Guinea and stressed the difficulties which arise at isolated stations when the equipment is not reliable and easy to repair.

Mlle. Pillet stated that the stations supported by the French organizations were satisfactory However, stations at Kinshasa-Binza and Lwiro had serious trouble since no foreign currency could be obtained to operate stations. The station at Tamanrasset was closed and no replies had been received from the station in Morocco. For historical reasons most Africans came to England or France for specialised training.

The meeting felt that an attempt should be made to help the African chain of stations and requested the Chairman to make further enquiries with both national and international bodies.

(c) Training Aids

All groups having training aids suitable for publication in the INAG Bulletin are requested to submit them to the correspondence column of the INAG Bulletin. The meeting felt that the most effective training aid would be to produce a training manual.

7. CCIR Problems for INAG Consideration

The main CCIR problems identified at the meeting have been discussed in the body of this report. Further problems would be forwarded unofficially by INAG representatives at the CCIR meeting so as to allow INAG discussion before Helsinki. The revised version of "Opinion 22-2" is likely to be approved in June and can then be accepted as an official document for INAG purposes.

8. Ionogram Problems

(a) F2 Lacuna

Mlle. Pillet presented a paper by M. Silvain showing that F2 Lacuna was a real phenomenon which occurred frequently enough at Terre Adelie to modify the median value of foF2 by more than 1 MHz. This paper will be found on page 34.

The meeting agreed that the evidence was convincing and that F2 Lacuna could have a serious effect on the interpretation of foF2 medians at stations where Lacuna were common. It was felt that it was probably undesirable to introduce F2 Lacuna for worldwide use since this could cause much confusion at stations where Lacuna were uncommon and the operators would have difficulties in distinguishing between an F2 Lacuna and a G condition. However, at stations where Lacuna were common, the instructions given in INAG-9, pp. 5-10, should be adequate and the use of Y for F2 Lacuna should be encouraged. Although the replacement of F2 by Y values with foF1 present normally shows that this convention is in use, it is recommended that a note be added to the data sheets for stations identifying F2 Lacuna.

(b) University of Queensland Phase Ionograms

The ionograms sent to INAG by Dr. Cole were shown to the meeting and discussed briefly. These are reproduced on page 28. Dr. Turunen commented that the IS-14 ionosonde could be modified very simply to to give similar data and that, in its present form, the height at the point where the trace jumped from one 3-km unit to the next was known to a very high accuracy.

(c) IS-14 Ionograms

Dr. Turunen discussed the problems of the optimum interpretation of ionograms from the IS-14 ion ionosonde using as examples the ionograms reproduced in the manufacturer's brochure. The ionosonde at Sodankyla had been set up with a relatively narrow dynamic range for recording. In conjunction with the signal-controlled AVC, this removes most difficulties in interpreting the standard and the gain sensitive parameters. He stated that, after this ionosonde had been adjusted to its present mode of operation, no foF2 values had been lost due to the presence of spread-F (it is hoped that these or similar ionograms will be made available in a future INAG Bulletin, for discussion in Uncle Roy's column).

The Chairman pointed out that the behavior of the gain curve for determining the value of fbEs when Es was totally blanketing was equivalent to the use of multiple reflections from a conventional ionosonde, and could be more reliable when it showed a clear discontinuity at fbEs. Such values could be treated as exact equivalents of fbEs.

A feature of the ionograms from this ionosonde is that the gain sensitive parameters, spread F, foEs, fbEs, are little affected by changes in absorption or noise level.

9. Any Other Business

(a) Japanese Ionospheric Satellite

Dr. Hakura said that the Japanese hoped to launch the ISS-b (Ionospheric Sounding Satellite -b) on February 11, 1978. This satellite should contribute to ionospheric research and to the prediction service by providing global topside sounder data (TOP). Additional data will be provided by the retarding potential analyzer (RPT), positive ion mass spectrometer (PIC) and radio noise meter (RAM). The ISS project manager is Dr. N. Wakai, the Head of Radio Wave Division (RRL), Japan, to whom inquiries should be addressed.

(b) Collaboration with the People's Republic of China

Dr. Hakura raised the question of whether INAG could invite the People's Republic of China to participate in the world cooperative observation network. Mr. McCue stated that he had visited China and found an active network. The Chinese were well informed on ionospheric problems but at present their policy was to exchange data on a strict bilateral level, use of the data being restricted to the institutes involved. It is clearly impractical for INAG to proceed further until the Chinese authorities are willing to cooperate in the same way as other cooperating bodies. This appears to be a political problem in which INAG is not involved. However, if and when the People's Republic of China is willing to participate normally, INAG would be happy to welcome them and to help to make the collaboration effective.

(c) World Data Center Guide

The Secretary stated that the World Data Center Guide was likely to be revised in the near future and inquired whether INAG wished to change the rules for interchange of data in it. Problems had arisen with the interchange of ionograms between the different data centers mainly because of the cost of duplicating all ionograms submitted to a given WDC. The practice at WDC-A, and apparently at most of the WDCs was to exchange ionograms from a limited number of stations only, but to list ionograms obtained under the RWD and other programs. WDC-A was prepared to copy ionograms loaned to them by stations who could not afford to copy them and thus make them available for wider study. These ionograms were mostly studied by visitors to the WDC but could be made available economically to bonafide workers requiring ionograms for limited periods. The feeling of the meeting was that this was probably the most economical solution though it could impose some delays in meeting specific requests and increase the risk of accidental destruction. The need to keep the data interchange uniform until at least the end of the IMS really prevented any significant changes in the Guide other than those imposed by current practice differing from the original recommendations.

(d) WDC Catalogs

The Secretary inquired whether INAG would prefer to have limited catalogs covering particular fields only, revised and published as they become available, or whether these should be kept until the whole Data Center Catalog had been revised. It was unanimously felt that sectional catalogs made available soon after revision were more valuable than waiting for a complete catalog and the need to file these was not a serious difficulty. The Secretary would bring this view to the attention of the appropriate committee.

III. IONOSPHERIC NETWORK ADVISORY GROUP FUTURE MEETINGS

INAG Meeting to be Held During URSI General Assembly,
1-10 August 1978 at Helsinki, Finland.

A formal meeting of INAG will be held in Helsinki during the URSI General Assembly, August 1-10, 1978. INAG attempts to consolidate its work at the three yearly meetings of the URSI General Assembly and to plan for the next 3 years. This year the most important items on the Agenda are the Needs for a VI Network in the 1980's, the international programs of work and the parameters to be interchanged in the 1980's. Many comments on these matters will be found in the INAG Bulletin. *It is very important that you should let INAG know your views at Helsinki.* For this reason we have circulated all National Representatives on Commission G with a request to collect such views. We hope that there will be a wide representation at Helsinki so that decisions can be made in time to be put into action in 1980. Do not wait until the last possible moment - we can only get the right compromise if your views are made widely known. In accordance with the recommendation of the INAG meeting at Geneva, the proposed Agenda is reproduced below.

A G E N D A

1. Chairman's Introduction
2. Matters arising from INAG meetings in last 3 years.
3. Consideration of URSI/INAG Report on "Needs for Ionosondes in the 1980's"
   (a) Preparation of comments for Commission G.
   (b) Future Action by INAG.
4. Status of Network.
5. Handbook and High Latitude Supplement.
6. INAG Bulletin.
   (a) Status
   (b) Future Contents
   (c) Finance
7. Training Problems.
   (a) Reports from participants.
   (b) Needs of underdeveloped countries.
   (c) Proposed training manual.

8. Status of New Ionosondes.

9. Ionogram Problems.

10. Any other business.

INAG Meeting at Canberra, Australia, 2-15 December 1979

Preliminary notice is now given that INAG intends to hold a formal meeting during the IAGA General Assembly at Canberra, Australia, December 2-15,1979. This will be organized by the local INAG member, Dr. D. Cole. The Agenda will be revised at the URSI Meeting in Helsinki. The provisional Agenda is at present:

A G E N D A

1. Chairman's Introduction.
2. Discussion on Helsinki Report.
3. Actions needed on 'Needs for Ionosondes in the 1980's'.
4. Action on proposed new stations and closure of existing stations.
5. Training problems. Use of Handbooks.
6. Equatorial station networks problems.
7. Changes in parameters, letter symbols and programs.
8. Status of network.
9. Status of new ionosondes.

Further suggestions for this Agenda should be send to the Chairman or Dr. D. Cole.

IV. Training Manual

As you will have seen from the INAG Bulletins, there is some feeling that a training manual would be useful. The production of such a manual is a very major job which should not be attempted unless it is really desirable. *In your view, is there a real need for such a manual?* I suspect that it will take at least a year to produce. *Would it be more useful than putting additional training aids and discussions in the INAG Bulletin?*

You will have noticed that the last two Bulletins have been very short because your Chairman could only spare time to consider the reports of the INAG meetings.

I badly need the considered views of the INAG members on whether we should support the suggestions which have been made to simplify and reduce the parameters to be interchanged in the 1980s. We have worked very hard to try to get the existing parameters to the stage where they produce uniform data and any significant simplification must, of course, lower our current standards and also involve the discontinuity between data obtained before and during the IMS with data obtained at later dates. *Is this desirable?*

The simplest solution would be to omit certain parameters altogether, the most popular suggestion is to cease to circulate Es types, and possibly simplify the Es reduction rules. In particular, the Es symposium recommended that fbEs is more useful than foEs. *Is it now time to cease recording foEs?* I would welcome your considered opinion so that I can guide the discussions at Helsinki. *PLEASE READ the INAG Bulletin for the last 3 years and let me know your views on the points raised in them which THE INAG BULLETIN FOR THE LAST 3 YEARS AND LET ME KNOW YOUR VIEWS ON THE POINTS RAISED IN THEM WHICH SHOULD BE DISCUSSED AT HELSINKI.*

V. Comments on the "Report on Needs for Ionosondes in 1980s"

The following comments on the Report on Needs for Ionosondes in the 1980's have been made by L. Bossy of the Institut Roual Meteorologique, Belgium, who was a member of Dr. Rishbeth's Working Group.

"1. In view of the fact that the final version of the Report was not circulated to the Members of the Working Group for approval, Dr. Rishbeth has invited me to comment on a particular aspect of the Report which which I do not agree.

"2. In para. 5(b), the Report correctly states that one of the reasons for the existence of a network of ionosondes is to permit studies of smaller-scale variations. Past and recent examples of these are investigations of transport phenomena, the distribution of Es, relations with regional geomagnetic and geographical features, and very recently, the determination of exchange tensors in the upper atmosphere for which relatively dense networks are necessary. However, para. 11 is incomplete since it makes no reference to the need for such networks and it seems necessary to repair the omission and to add the following: "11(d). Dense groups of stations designed to permit the study of small-scale variations and to elucidate anomalies."

"3. We must recognize that once an ionosonde has been closed down, its reactivation is extremely improbable. It seems to me that para. 15 adopts an unnecessarily pessimistic attitude and I do not believe our Working Group has any justification for assuming that a reduction in the network is inevitable. I suggest that the following version of para. 15 would be preferable: "15. If after the IMS the economic situation is such that there must be a reduction in the size of the present network, such a reduction ought to be made taking into account the considerations given in para. 74. In any case, the size of the network must be maintained at a level above the minimum required for scientific research."

"4. Quite generally, there is evidence for the existence of interrelations between the upper and the lower levels of the atmosphere and it follows that regional studies will be of increasing scientific importance. It is fortunate that several dense regional networks already exist and every effort should be made to maintain these."

VI. COSPAR Decision No. 7/76

INAG has received a copy of COSPAR Decision No. 7 of 1976 through the Secretary General of URSI. This decision draws our attention to the importance of ionosondes at key locations, to those concerned with research using spacecraft, and invite us to define the requirements more precisely, as noted in the report below. This decision was considered by the INAG Meeting at Geneva and it was felt that it could best be linked with the review of the network to be carried out in each sector by the INAG members. The response to the decision should be made at the INAG meeting at Helsinki. *If you have particular points that you wish to be included, please inform the Chairman, Secretary, or your nearest INAG member as soon as possible so that they can be included in the next INAG Bulletin.*

COSPAR Decision No. 7/76 Proposed by the Executive Council on a Proposal from Work Groups 4 and 1

COSPAR:

noting that ionosonde records complement spacecraft electron density data by providing detailed profiles with high time and altitude resolution at fixed locations for long periods of time,

draws the attention of URSI and CCIR to the need for an adequate network of ionosondes at key locations supplemented by special purpose temporary stations, and

requests URSI to define these requirements more precisely.

VII. Reports from Stations

1. Argentine Network

The ionosondes of the Argentine network are coordinated by the International Programme of Radio Propagation (PRONARP) but are run by different organizations. Tucuman and Buenos Aires operated normally during 1977. General Belgrano (Antarctica) also operated but the sequence was broken from the middle of August to the middle of October, 1977, due to power shortage at the base. San Juan, Trelew, Ushuaia, were not operational during 1977. San Juan is expected to reopen using a refurbished C3/4 ionosonde supplied by NOAA. Ushuaia will soon be reopened. It is planned to modernize the C4 at Buenos Aires during 1978 and the Belgrano ionosonde will also have some components replaced.

2. New Zealand Network

(a) Refurbished Ionosonde at Campbell Island

For the last 18 years, a C4 ionosonde on loan from NOAA has been operating on Campbell Island (-59.8, invariant latitude) as part of the New Zealand network of ionosondes. The shortage of spares for this instrument led to its replacement by a refurbished C3 on loan from the same group (see INAG-26, p. 20). The new ionosonde was installed in January 1976 and has been operating very well in the past 24 months. The records show better resolution of the sweeps of the display time base, greater stability of frequency and height markers, and generally a better presentation of the received echoes.

(b) Digitizing of Data

Data from NZ network stations are now being processed by means of a digitizing table and a mini-computer. Film records are projected onto the table and interpreted, the position of a freely movable detector determining the value of frequency or height to be assigned to a given parameter. Qualifying and descriptive letters are added by referencing a 'menu' - a fixed array of values in a special area of the digitizing table. The output from the table is fed directly into the computer which is programmed for all the necessary checks for conformity with scaling rules, consistency of data values, misreadings and "out-of-bound" values. The data are stored in suitable files on disk and other sections of the program allow editing and correction of the data, computation of monthly median values and printing of monthly data sheets for up to 14 parameters.

Introduction of this system has reduced the time required to produce the monthly data sheets by about one-half and, of course, eliminates much of the handwork and error-producing transfers formerly needed. Indeed, the film interpreter needs to write down only the remarks about the scalings - everything else is done by the equipment.

(c) Data from NZ Network

Film records from Christchurch and Rarotonga are routinely scaled through the digitizing system and during summer (when the film can be flown out weekly), the Scott Base records are being treated the same way. However, some data will still be hand-processed since Scott Base is not accessible from mid-February until September each year, and Campbell is infrequently visited, only the yearly servicing trip is certain.

The intention then is to publish:

(i) Eleven parameters from Christchurch, Rarotonga, and Scott Base (summer only), and

(ii) foF2 from Scott Base (winter) and Campbell Island at monthly intervals.

When the film from Scott Base and Campbell Island becomes available (after servicing of these stations), the 11 parameters will be published for each of these stations.

The parameters to be published until the end of IMS are: fxI, foF2, foF1, foE, foEs, fbEs, fmin, h'F, h'E, h'Es, M(3000)F2.

(d) Rarotonga

A new officer-in-charge has been installed at Rarotonga (Cook Islands) Observatory, at which a P2 ionosonde has been operating since 1957. Alan Cresswell was formerly in charge of the ISIS Satellite Telemetry facility at Lauder, Central Otago in New Zealand.

(e) Future of New Zealand Ionosonde Network

The New Zealand chain of ionosondes, Rarotonga (-19.8 invariant latitude), Christchurch (-49.8), Campbell Island (-59.8) and Scott Base (-79.7) has been evaluated by the controlling administration, and a preliminary decision has been made to close the Rarotonga ionosonde at the end of the IMS (December 1979). In accordance with recommendation 2 of the IAGA at its 3rd Scientific Assembly, quoted in INAG-26, p. 7, *the scientific community is invited to comment on the importance of Rarotonga, and whether the station should continue operation and for what reasons.* Comments should be addressed to:

Officer-in-Charge
PEL Geophysical Observatory
D S I R
P.O. Box 2111
Christchurch, New Zealand

Chairman's Comments

Dr. R. S. Unwin requests views on whether Rarotonga or Scott Base is the more important if one has to be closed. *If you have a view on this, please inform the Chairman.* At first sight, the relative importance appears similar for both stations.

If any other Administration would be willing to run an ionosonde at Rarotonga, he would be prepared to replace the New Zealand P2, at present in use by a refurbished C4, which operated at Campbell Island until 1975. This ionosonde would be handed over as an operational instrument. *Will anyone wishing to take advantage of this offer contact:*

Dr. R. S. Unwin
D.S.I.R. Geophysical Observatory
P.O. Box 2111
Christchurch, New Zealand

This station is conjugate to Maui, Hawaii. The Geophysical Observatory at Rarotonga also contains a seismograph and is partly staffed by Rarotongans though run by the New Zealand D.S.I.R.

VIII. Employment of Operators

From time to time, the Chairman has been approached by V.I. station operators or analysis staff who have wished to work in another part of the world and he has sometimes been able to suggest Administrations for them to contact. Most requests have, of course, come from B.A.S. ionospheric field staff who are never employed in B.A.S. for more than two tours of duty (four Antarctic winters). The Chairman would be glad to hear from any Administration who might be interested in employing such staff.

IX. Status of New Ionosondes

The following information was provided by Dr. Turunen and Mr. McCue:

(a) Finnish IS-14 Ionosonde

This ionosonde has previously been discussed in INAG-23, p. 6; INAG-22, pp. 13, 19-20; INAG-20, pp. 8-9. Dr. Turunen described the behavior of the commercial version of the IS-14 ionosonde as set up for synoptic observations at Sodankyla. The reliability of instruments had been outstandingly good. A description and specification leaflet produced by the manufacturers was tabled. Copies can be obtained from the Chairman or from: KLT Elektroniikka Oy, Linnaukatu 1, SF 00160 Helsinki 16, Finland.

The instrument has been specially adjusted to allow the standard parameters to be measured with minimum difficulty when weak or spread echoes are present. It is designed to give consistent values for gain sensitive parameters such as foEs, fxEs, fbEs, fxI, despite changes in absorption or noise level. Each frequency is sounded 10 times and the average recorded. This gives a very good signal-to-noise ratio with a peak pulse power of 5 kW. The AVC voltage corresponding to the strongest reflection present is recorded on the ionograms and weak reflections are recorded when they reach a certain preset fraction (at Sodankyla -20 dB) of this signal. The gain is locked when the ray disappears giving a fixed sensitivity on frequencies above foF2 relative to the ray signal near foF2.

He stated that the selection criteria could easily be changed to suit particular types of research but believed that the criteria in use at Sodankyla gave the best compromise for the production of quantitatively accurate synoptic data. Eight different sounding programs were provided giving soundings at 1-hour, 30-min, 15-min, 10-min, and 5-min intervals, and at 1 hour intervals, and 5 min before and after the hour, and manually. The main specifications are:

Frequency range	0.5...16 MHz
Pulse power	5 kW
Pulse width	60 μs
Pulse frequency	50 Hz
Height range	70...1000 km
Height markers	every 100 km

Frequency markers	every 1 MHz
Real time clock display	sec, min, hour, day, month, year
Sweep rate	logarithmic, 40 s per octave
Receiver gain control	automatic or manual
Integrator	digital, 256 x 16 bit (128 x 3 km + 128 x 6 km)
Display modes	Panoramic and A-scan
Recording	Panoramic display with AGC voltage time indication and station identification code
Recording film frame	24 x 36 mm
Power consumption	appr. 600 VA, 220 V AC, 50 Hz
Weight	appr. 250 kg
Ambient temperature	0...40°C
Relative humidity	20...90%
Cabinet dimensions (incl. transmitter)	1600 x 1200 x 600 mm

Options:

110 V/60 Hz power supply
External synchronization of output pulses
Digital data output
HP 1335A memory display
Modified Coleman KD 5 registration camera
Automatic mains voltage stabilizer
Battery power supply for clock

(Specifications subject to change without notice)

(b) Australian 4A Ionosonde

This ionosonde has been described in INAG 21, pp. 3, 14; INAG 18-19, pp. 35-36; INAG 17, p. 4; INAG 15, p. 19.

The low price quoted in INAG 21, p. 14, is approximately correct. Since the Lima meeting, there has been considerable modification to the original design. The instruments deployed in the Australian network are being modified as shown below:

The level of interfering noise on the ionograms is indicated by displaying the AGC voltage under the 50-km height marker.

The 4A receiver has been redesigned to increase its dynamic range. This will alleviate to some extent the effect of interfering signals, particularly at the low frequency end.

The purpose of the redesign is to expand the memory so that amplitude information (256 levels) can be recorded as well as height and frequency. The redesigned ionosonde can now be used with micro-processor control of timing and programming. Methods of exploiting the micro-processor are being developed. A film consumption indicator has been built which gives a four-digit readout of number of frames or length of film exposed up to 9999 frames or 99.99 m.

A frequency readout unit to provide transmitter frequency for constant frequency or maintanance purposes, maximum frequency indicated 19.99 MHz.

An amplitude indicator device which can be used to show the amplitude of interfering signals.

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(c) ASHAY/SHISG Ionosonde

Dr. Perez reports that the command unit to be built in Argentina is half constructed. The remaining half has been designed and only some compatibility problems remain to be solved. It has now been decided to use commercially built oscilloscopes for monitoring and recording.

X. Scaling Errors in Ionospheric Characteristics

P. J. Wilkinson
Ionospheric Prediction Service
Australian Department of Science

Introduction

Ionospheric characteristics are scaled from ionograms using rules set out in the URSI Handbook of Ionogram Interpretation and Reduction, UAG-23. It is important to be aware of the likely errors introduced into the data in the scaling for individual hourly values and also for statistical studies. To assess these errors a film containing 216 ionograms drawn from the Australian stations - (Casey, Mawson, Hobart, Canberra, Mundaring, Brisbane, Norfolk Island, Townsville and Vanimo), was scaled by the twelve operators currently manning the Australian stations. The scaling conditions were kept as close to normal as possible by selecting 2 half days of ionograms representative of both summer and winter at each station. Sequences of ionograms could then be used to help interpret the hourly scaling, as is normal practice. The scalings of the twelve operators were compared and typical errors were estimated for each of the twelve ionogram characteristics scaled - foF2, fxI, foE, fmin, M(3000)F2, h'F, h'E, h'Es, foEs, fbEs, and type of Es. These results can be used to estimate the normal accuracy with which ionospheric characteristics may be scaled and the consistency between scalers in the use of the qualifying and descriptive letters. The following tables and diagram summarize the results of the exercise.

Table 1.

Characteristic	Median (all data)			Median (data when no scaling letters used)		
	Average Median	Standard deviation	Range (max-min)	Average Median	Standard deviation	Range (max-min)
foF2 (MHz)	5.1	0.2	0.5	5.7	0.1	0.3
fxI (MHz)	5.8	0.1	0.2	-	-	-
foF1 (MHz)	4.2	0.1	0.1	4.3	0.1	0.3
foE (MHz)	2.8	0.08	0.3	2.9	0.09	0.3
fmin (MHz)	1.5	0.1	0.1	1.7	0.1	0.4
foEs (MHz)	3.6	0.2	0.6	3.6	0.1	0.5
fbES (MHz)	3.0	0.2	0.4	3.2	0.1	0.4
M(3000)F2	3.06	0.05	0.2	3.10	0.06	0.2
h'F (km)	235	5	14	230	7	20
h'E (km)	108	3	8	108	4	9
h'Es (km)	108	4	8	109	4	9

Average medians for twelve scalers. The average median, standard deviation and range of medians for the twelve scalers indicate the limits of agreement for the characteristics scaled. Two cases were considered - using all data and using only data when there was no qualifying or descriptive letter.

Table 2.

Characteristic	Total number of ionograms used for each sample	All scalers agree %	One scaler disagrees %	Two scalers disagree %	More than two disagree %
foF2	204(147)	62(87)	15(9)	7(2)	16(2)
fxI	202	86	8	4	2
foE	78	64	12	5	19
foF1	36	50	31	8	11
M(3000)F2	143(90)	47(72)	22(23)	5(1)	26(4)
h'F	190	63	11	6	20

Percentage of ionograms that scalers agree can, or cannot, be scaled. An ionogram characteristic may be scaled with a value or, if the accuracy limits are exceeded, with a replacement letter. The percentage of ionograms for which scalers agreed, or disagreed, on the scaling used are shown in the table. Bracketed values are the percentages obtained when all ionogram characteristics that had the descriptive letter "F" used with them were removed. (All percentages are rounded to the nearest whole number.)

Frequency markers	every 1 MHz
Real time clock display	sec, min, hour, day, month, year
Sweep rate	logarithmic, 40 s per octave
Receiver gain control	automatic or manual
Integrator	digital, 256 x 16 bit (128 x 3 km + 128 x 6 km)
Display modes	Panoramic and A-scan
Recording	Panoramic display with AGC voltage time indication and station identification code
Recording film frame	24 x 36 mm
Power consumption	appr. 600 VA, 220 V AC, 50 Hz
Weight	appr. 250 kg
Ambient temperature	0...40°C
Relative humidity	20...90%
Cabinet dimensions (incl. transmitter)	1600 x 1200 x 600 mm

Options:

110 V/60 Hz power supply
External synchronization of output pulses
Digital data output
HP 1335A memory display
Modified Coleman KD 5 registration camera
Automatic mains voltage stabilizer
Battery power supply for clock

(Specifications subject to change without notice)

(b) Australian 4A Ionosonde

This ionosonde has been described in INAG 21, pp. 3, 14; INAG 18-19, pp. 35-36; INAG 17, p. 4; INAG 15, p. 19.

The low price quoted in INAG 21, p. 14, is approximately correct. Since the Lima meeting, there has been considerable modification to the original design. The instruments deployed in the Australian network are being modified as shown below:

The level of interfering noise on the ionograms is indicated by displaying the AGC voltage under the 50-km height marker.

The 4A receiver has been redesigned to increase its dynamic range. This will alleviate to some extent the effect of interfering signals, particularly at the low frequency end.

The purpose of the redesign is to expand the memory so that amplitude information (256 levels) can be recorded as well as height and frequency. The redesigned ionosonde can now be used with micro-processor control of timing and programming. Methods of exploiting the micro-processor are being developed. A film consumption indicator has been built which gives a four-digit readout of number of frames or length of film exposed up to 9999 frames or 99.99 m.

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fxI (MHz)	5.8	0.1	0.2	-	-	-
foF1 (MHz)	4.2	0.1	0.1	4.3	0.1	0.3
foE (MHz)	2.8	0.08	0.3	2.9	0.09	0.3
fmin (MHz)	1.5	0.1	0.1	1.7	0.1	0.4
foEs (MHz)	3.6	0.2	0.6	3.6	0.1	0.5
fbES (MHz)	3.0	0.2	0.4	3.2	0.1	0.4
M(3000)F2	3.06	0.05	0.2	3.10	0.06	0.2
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Percentage of ionograms that scalers agree can, or cannot, be scaled. An ionogram characteristic may be scaled with a value or, if the accuracy limits are exceeded, with a replacement letter. The percentage of ionograms for which scalers agreed, or disagreed, on the scaling used are shown in the table. Bracketed values are the percentages obtained when all ionogram characteristics that had the descriptive letter "F" used with them were removed. (All percentages are rounded to the nearest whole number.)

Table 3.

Characteristic (units)	Minimum Division size used	Data grouping	% of scaling within ± minimum division	Deviations from 'median scaling'		% deviations from 'median scaling'		Sample size for upper decile
				median	upper decile	median	upper decile	
foF2 (MHz)	0.1	ALL	75	0.06	0.2	0.9	5.5	1853
		*	89	0.01	0.1	0.1	2.3	873
fxI (MHz)	0.1	ALL	70	0.06	0.3	0.9	5.8	2082
		*	56	0.1	0.5	1.6	8.8	678
foF1 (MHz)	0.1	ALL	93	0.01	0.1	0.1	2.5	617
		*	95	0.01	0.1	0.1	2.5	266
foE (MHz)	0.05	ALL	61	0.05	0.2	1.5	6.0	932
		*	69	0.07	0.1	0.1	3.8	374
fmin (MHz)	0.1	ALL	76	0.06	0.2	3.0	14.4	2302
		*	83	0.01	0.1	0.1	8.4	1081
foEs (MHz)	0.1	ALL	55	0.1	0.6	2.0	15.5	1166
		*	59	0.06	0.5	1.6	12.0	1026
fbEs (MHz)	0.1	ALL	67	0.06	0.3	1.4	12.6	1134
		*	80	0.01	0.1	0.1	6.5	664
M(3000)F2 (-)	0.05	ALL	50	0.05	0.3	1.7	7.8	1630
		*	61	0.05	0.2	1.5	5.3	867
h'F (km)	5	ALL	77	0.7	10.5	0.1	4.3	1786
		*	84	0.7	5.7	0.1	2.5	783
h'E (km)	5	ALL	79	0.7	10.5	0.1	9.2	816
		*	90	0.6	5.6	0.1	4.9	572
h'Es (km)	5	ALL	84	0.6	5.6	0.1	4.9	1219
		*	85	0.6	5.6	0.1	4.9	1180

The median and upper decile deviations and percentage deviations from the median scaling for a single ionogram characteristic are tabulated for all scaled values independent of scaling letter usage (ALL) and only those values that no scaling letters were used (*). The percentage of scaled values within a minimum scaled division of the median scaling indicates a measure of objective errors in scaling. (For intercomparison of characteristics the sample size for the upper decile is included.)

Table 4.
Qualifying Letter Usage

MODE SCALING FOR THE SAME IONOGRAM	Blank	A	D	E	J	O	U	OTHER	TOTAL IONOGRAMS USED
Blank	88		1	4		1	5	1	1968
A	14	79		6			1		11
D	32		53	1		2	8	4	7
E	12			86			1		249
J	28		3	8	47		11	3	3
O	30					69	1		7
U	29		1	1			69		131

Table 5.
Descriptive Letter Usage.

MODE SCALING FOR THE SAME IONOGRAM	Blank	A	B	C	E	F	G	H	L	Q	R	S	V	X	Y	OTHER	TOTAL IONOGRAMS USED
Blank	86	2	2			1	1	2		1	1	3				1	1405
A	14	75	3			1	1	1			2	2				1	187
B	7	1	80	5	3		2				1	1					104
C	25			60							4			3		8	8
E	4		13		61							22				0	36
F	8					83	1	1			2	4	1				162
G	13		4		4		74					4				1	·66
H	28	2						66	1		1	1			1		32
L	19							9	72								22
Q	33	3	1							50	1	12					13
R	24	3	5			1		6			49	2			8	2	13
S	11	1	10		7	1						69		1		1	211
V	8							17					75				1
X	4										1	2		93		0	114
Y	21							21			8				50		2

For each ionogram and characteristic, the scaling letter used by most of the scalers (the mode) is compared with the letters used by all the scalers. As the rules for letter usage are essentially the same for all characteristics, the scaling letters are treated collectively in the two tables. The rows of the tables are all normalized to give the percentage occurrence of the mode scaling and alternative scalings for each letter when it was the mode.

Table 6.

%	Blank	a	c	f	h	k	l	n	q	r	s	Other	Total ionograms used
Blank	88		2	4	3		1			1		1	66
a	13	42		4	4		8			25	4		2
c	3		70	1	18		7					1	51
f	2	3	1	91					1	1		1	60
h	8	1	22	2	52		12			1		2	14
l	7	1	14	5	9		63			1			17
r	14	1	4	4	1	11	1	1		57	6		6

Es types scaled with mode scaling. Type of sporadic E scaled as most important on an ionogram. This table was produced in the same way as Tables 3 and 4.

Table 7.

Hour	-1	0	+1	+2	+3	
foE value scaled	6	77	90	92	90	%
replacement letter scaled	2	14	10	8	10	%
TOTAL	8	90	99	100	100	%

Epoch analysis of foE scaling. The zero hour for the epoch analysis was taken as the time when at least 9 of the 12 scalers scaled foE for the first (in the morning) or last (in the evening) time. The percentage of the total number of scalings possible is used to indicate the agreement between scalers on the appearance of the normal E layer.

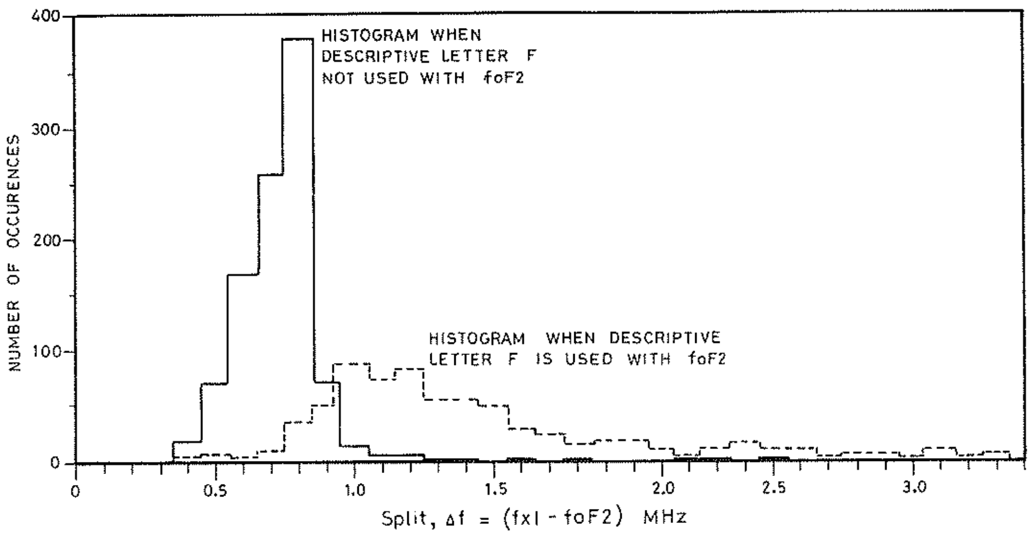

Figure 1. Histogram of Δf = (fxI-foF2) for 0.1 MHz intervals.

Two histograms are shown, the first in which no descriptive letter 'F' is used with foF2 and the second, where it is. The first peaks sharply at the average magnetoionic split for the sample, the second histogram is flatter having no peak at the magnetoionic split.

Conclusions

1. The medians for all scalers were within 5% of the average median for all characteristics analyzed. Table 1 shows that the agreement between scalers' medians is good, the standard deviation for all scalers' medians being small. The difference between medians obtained using all data and when excluding data with qualifying or descriptive letters is not significant for any characteristic other than foF2, though because the scaling was consistent for the two groupings of data this is not considered important.

   In general, different scalers should not produce significantly different medians provided they follow correct scaling procedures.

2. It is apparent, from Table 2, that while scalers do not agree all the time on whether an ionogram characteristic is scalable within the accuracy limits or not, 10 or more out of 12 agree 80 to 90 of the time. When all ionogram characteristics with the descriptive letter "F" were removed the agreement between scalers for foF2 and M(3000)F2 improved indicating the degree of uncertainty in scaling in the presence of Spread F.

3.(a) In Table 3, the upper decile percentage deviations for these values requiring no scaling letters are within the recommended accuracy limits (less than 5%, UAG-23) for foF2, foF1, foE, h'F, h'E and h'Es. Both fmin and foEs have large errors suggesting subjective errors are large even when no scaling letters are used.

(b) Errors in M(3000)F2 are large when compared with the range of values scaled. The interdecile width (range between deciles) is 0.8 for all values scaled, which is comparable with the scaling error of 0.2. Errors due to using a single M(3000)F2 scaling sheet instead of one for each individual station were checked for and found unimportant. The major problem is that M(3000)F2 is derived from two measurements. Errors in fitting the M(3000)F2 curve will be comparable to or greater than errors in h'F and errors in reading the M(3000)F2 value will be comparable to or greater than errors in h'F and errors in reading the M(3000)F2 value will be the same as errors in foF2. The error in M(3000)F2 is, in fact, comparable to the combined foF2 and h'F errors.

(c) Incorrect interpretation of ionogram scales occurred in about 0.5% of the data scaled. Height errors showed a minor peak of ±50 km and frequency errors a peak at ±1 MHz.

(d) Subjective errors are important in fmin. Even when no scaling letters are used, indicating some degree of certainty in the scaling of fmin, the errors are relatively large. Errors here are probably due to unfamiliarity with different station's frequency scales and local interference bands. Because of this, it will not be reasonable to regard the fmin errors as typical of a competent station operation scaling familiar ionograms.

4. Tables 4 and 5 show that the scaling letters are used satisfactorily. The first choice after the mode scaling is a blank, i.e., no scaling letter is used, and these two choices together account for 85% of the scaling letters used.

5.(a) Various subjective errors arise in scaling sporadic E characteristics. To eliminate problems due to different layers being selected as most important only those scalers' results that agreed with the most scaled type of Es were used in the analysis. Two further identifiable errors that remained were scaling fxEs as foEs and scaling an E2 layer as a sporadic E-layer. Other less obvious errors remained and contributed to the large errors shown in Table 3.

(b) Type of Es was scaled satisfactorily. While large errors appear in Table 6, generally these errors were due to disagreement about the most important layer. Notably, the blank is no longer the second letter choice.

6. Errors due to scaling will not significantly affect the use of foE as an indicator of station local time. From Table 7, while the scalers were unaware of the exact local time of sunrise or set for the stations being scaled, they disagree on the appearance and disappearance of the E layer only 9% of the time.

7.(a) The descriptive letter "F" is a useful qualitative indicator of the presence of spread F. Figure 1 shows two histograms of (fxI-foF2), one, when "F" is not used with foF2, being sharply peaked at the magnetoionic split, and the second, when "F" is used with foF2 being flatter showing a wider range of values for the split. This is taken as evidence that spread F is present.

(b) From Table 5, the descriptive letter "F" is scaled well in comparison with other scaling letters.

(c) Because of errors in foF2 and fxI, and because foF2 is often not scaled when spreading of the trace is present, it is difficult to use fxI as a quantitative indicator of spread F. More use could be made of fxI as an indicator of spread F width if a value, even if inaccurate, were scaled for foF2 and suitably qualified with a new qualifying letter to prevent any other use of this value ("F").

8. The scaling of all 12 scales was sufficiently similar so as to make it unrealistic to rank one individual as clearly better or worse than all the others. However as a group, the more experienced scalers, some of whom have been scaling ionograms with the Ionospheric Prediction Service for 20 years, scaled more consistently than the less-experienced scalers with only a few years' experience. The difference was not dramatic, though it was apparent that as a scaler becomes more experienced, the difficult ionograms are handled with the same skill as the easy ones. This was shown by the smaller upper deciles obtained by the more experienced scalers in their error distributions.

A more detailed account of this work will be published in an Ionospheric Prediction Service R series. The film made for the scaling exercise is held by World Data Center A, in Boulder, should other station networks wish to repeat the exercise. The analysis programs used to produce this report will be available in the R series.

XI. Secular Changes in the Ionosphere

W. R. Piggott

The importance of secular changes in the ionosphere was discussed at INAG, Geneva, where it was felt that they should be brought to the attention of the VI community. Since the dynamically controlled features of the ionosphere, for example, the shape and height of the F2 layer or the position of the zones of particle precipitation is mainly determined by the properties of the Earth's magnetic field. Long period secular changes in the field cause corresponding changes in the structure of the ionosphere. Few ionospheric workers realize how rapid these are. For example, the latitudes of the North and South Poles have changed by over 5° in the last 30 years (Piggott, Nature 213, pp. 379-80, 1967). In general, the main field pattern is drifting westward. For example, the rapid southward swing of the magnetic dip equator over the Atlantic sector is moving relatively rapidly westward. In addition, the anomalies in the main field, e.g., the South Atlantic anomaly in total field strength, also show some additional local movement.

A dramatic example of such changes occurred in the U.K. During the war, the station at Burghead (Inverness) was a sub-auroral station with frequent blackout and stormy Es activity and was used as a storm-warning station by the U.K. South Uist rocket range, which is at exactly the same corrected geomagnetic latitude as Burghead, now sees such activity rarely - rockets to study particle events are frequently delayed for considerable periods. In fact, the number of occurrences of overhead aurora and their associated particle events have decreased by a factor exceeding 30!

Dr. J. King states that some work on this phenomenon is proceeding at the Appleton Laboratory. He feels, with reasonable certainty, that the world maps of foF2 in the year 2000 will be significantly different in pattern from those produced in the IGY (1957-58). I concur. Thus it is important that stations in zones where the magnetic field is changing rapidly and zones where ionospheric gradients are large should continue to operate.

XII. The Nature of the Ionospheric Characteristic foF1

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Cambridge CB3 OET

The presence of a ledge of ionization in the ionosphere, such as that which gives rise to the well-known F1 perturbation in virtual height (h') on ionograms, is characterized by one of two conditions:

(i) A maximum turning point in plasma frequency (f) as a function of height (h) at the point $P_F(h_F, f_F)$, specified by the conditions

$$G_F \equiv \left(\frac{df}{dh}\right)_{f_F} = 0 \; ; \left(\frac{d^2f}{dh^2}\right) < 0.$$

In this case, a discontinuous cusp results on an ionogram, and the scaled value of foF1 - defined as the frequency corresponding to the discontinuity - is identical to f_F. This is the classical critical frequency, foF1.

(ii) An inflection point at P_F, specified by the conditions

$$G_F > 0 \; ; \quad \left(\frac{d^2f}{dh^2}\right)_{f_F} = 0 \; ; \quad \left(\frac{d^3f}{dh^3}\right)_{f_F} > 0.$$

For these conditions the perturbation in h' remains continuous and foF1 is defined as the frequency at which the local maximum in h' occurs. However, for this case the scaled value of foF1 is not identical to f_F, but is always greater by a small variable amount Δf. This point appears to have been overlooked, both by those who formulated the international scaling conventions for foF1, and by the users.

The value of Δf in a particular instance depends, inter alia, upon the value of G_F. This relationship is illustrated by the figure, in which are presented results from numerical evaluations of h'(f) obtained using an empirical N(h) profile model described by Dudeney (1977). The figure shows the effect of increasing G_F from zero, keeping foF2, foE, f_F(=5.00 MHz), hmF2 and hmE constant. For clarity only the F1-ledge portion of the N(h) profile is shown. In this example, Δf increases smoothly from zero as a function of G_F. However, other similar tests reveal that the form of the variation depends on the actual shape of the N(h) profile in the vicinity of the inflection, and it appears that no simple generalized relations can be formulated.

This analysis raises two questions: (a) for what purpose is foF1 scaled routinely? and (b) are the current scaling conventions suited to these purposes? The values of foF1 which would have been scaled according to the standard international code (Piggott and Rawer, 1972) are shown in the Figure. Clearly, if foF1 is being used, knowingly or unknowingly, as an estimate of f_F, the scaling conventions are unsuitable. This is particularly true of the case depicted in the far right-hand panel of the Figure for which the accuracy symbol D (meaning 'greater than') is inappropriate; its inverse, E (meaning 'less than') would be much more sensible.

A review of the uses to which foF1 is put and the optimum scaling conventions required appears timely. The majority of practical observations will overestimate f_F by between 0.05 and 0.20 MHz. Clearly, foF1 data should be used with caution until the effect of the uncertainties has been properly assessed. In particular, until the implications of these results for the deduction of the MUF are resolved, it seems questionable whether the development of sophisticated new schemes for predicting foF1 based on past data is appropriate.

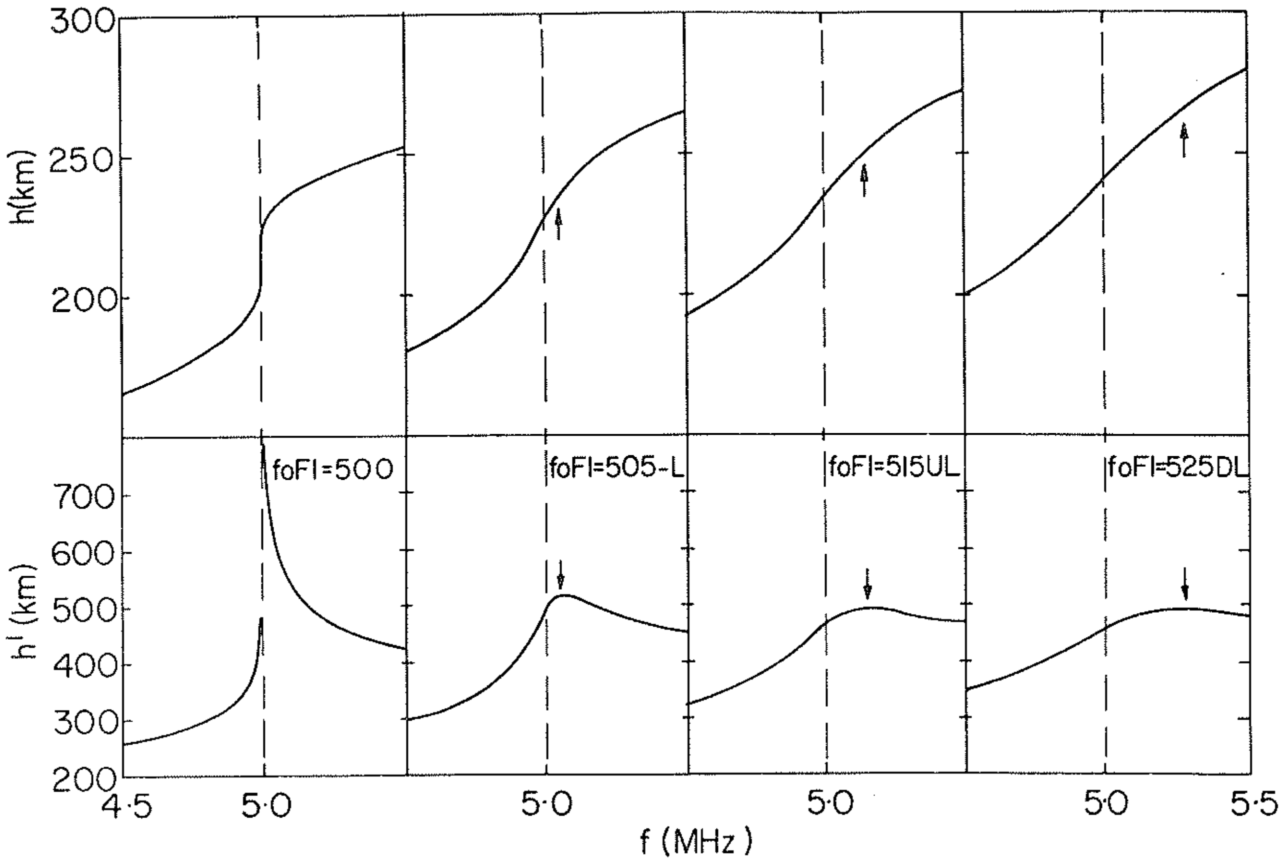

Figure 1. Demonstration of the effect of altering G_E upon the model value of foF1, assuming the chosen value of G_F is 5.00 MHz. The top half shows portions of model N(h) profiles, the bottom half the corresponding synthesized virtual height variations. The values of foF1 which would have been scaled according to the international conventions (Piggott and Rawer, 1972) are inset in lower portion. The virtual heights were computed neglecting the effects of collisions and the magnetic field.

References

J. R. Dudeney, "An improved model of the variation of electron concentration with height in the atmosphere," J. Atmos. Terr. Phys. (in press).

W. R. Piggott and K. Rawer, 1972. Report UAG-23, NOAA, Boulder, CO, 80303.

(Chairman's Comment: *Please express your views on this paper.*)

XIII. Queensland University Phase Ionosonde

Chairman's Note

David Cole, the INAG member for the Australian zone, has submitted the attached ionograms and notes for publication in the Bulletin. INAG wishes to invite other groups to submit similar material either directly to the Chairman, or through their local INAG member. The latter makes sure that adequate information is provided for INAG purposes. The phase information is shown by the dots which generate the traces. Medium waveband interference can be seen on the ionograms up to 2 MHz or slightly higher, suggesting that the HF amplifier is wideband. The ionograms were taken by Dr. Peter Monro, a member of the staff of Professor Whitehead's Department at Queensland University. Professor Whitehead suggested that they would be interesting to other workers since the addition of phase information can enable virtual height to be deduced within a few tens of meters. Normal scaling is 5 km with the best ionosondes giving a possible resolution of about 0.5 km.

"The phase ionosonde is situated on Bribie Island (27.0°S, 153.2°E), is swept in frequency from approximately 1 MHz to 8.5 MHz and can measure E-region heights with an accuracy of about 10 m. o-ray and x-ray recordings can be separated although the better recordings shown here are for the o-ray only. The frequency scale is linear and starts just below the 1 MHz marker; subsequent markers are 2, 3, 4, 5 and 6 MHz. The frequency is stepped at intervals of 15 kHz. The height marks are at 10 km intervals with larger markers at each 100-km step. At the top of each arch or at the valley bottom, the virtual height is an exact multiple of 10 km. The trace width is governed by the pulse width. The data are recorded digitally on magnetic tape and the final reduction has an error of the order of a few tens of meters in virtual height.

"No averaging is used on the film records. Each scan takes about 8 seconds and can be repeated as often as desired."

Uncle Roy's Notes on the Ionograms:

Figure 1. 08.09.76, 1140

A fairly common structured E layer with fmin = 019ES, foE = 315, foE2 (blanketed by Es) = 345-A or UA, foEs = fbEs = 034. Es = h, ℓ, foF1 = 430 with F1 and F2 layers separated. foF2 = 038. h'E = 106. h'Es = 123, h'F = 204, h'F2 = 314. There is much discussion at present on whether the lower Es trace should be called ℓ or c.

Figure 2. 08.09.76, 1325

Blanketing Es. All E-layer parameters A (the weak trace suggested foE = 310 UA) fmin = 020 ES, foEs = 044, fbEs = 043, foF1 = 430 UA. foF2 = 059. h'Es = 109, h'F2 = 290, Es = ℓ_1, ℓ_2. The lack of phase change with frequency on the lower Es type trace makes it fairly certain that this is not a trace from the bottom of the E layer. This is confirmed by its lower height relative to Fig. 1.

Figure 3. 21.09.76, 1405

Cusp Es, and a more common but partially blanketed F1 trace. E-layer trace classical.

Figure 4. 30.09.76, 1420

Low Es blanketing h'E. A very complex E layer which could only be scaled reliably by studying sequence. Probably foE = 285 with foE2 = 325 by analogy with Fig. 1.

Figure 5, 6. 12.10.76. 1130 and 1415

E and F1 traces spread. Note confusion in phase pattern where overlapping echoes present with occasional clean patterns when a dominant ray is present.

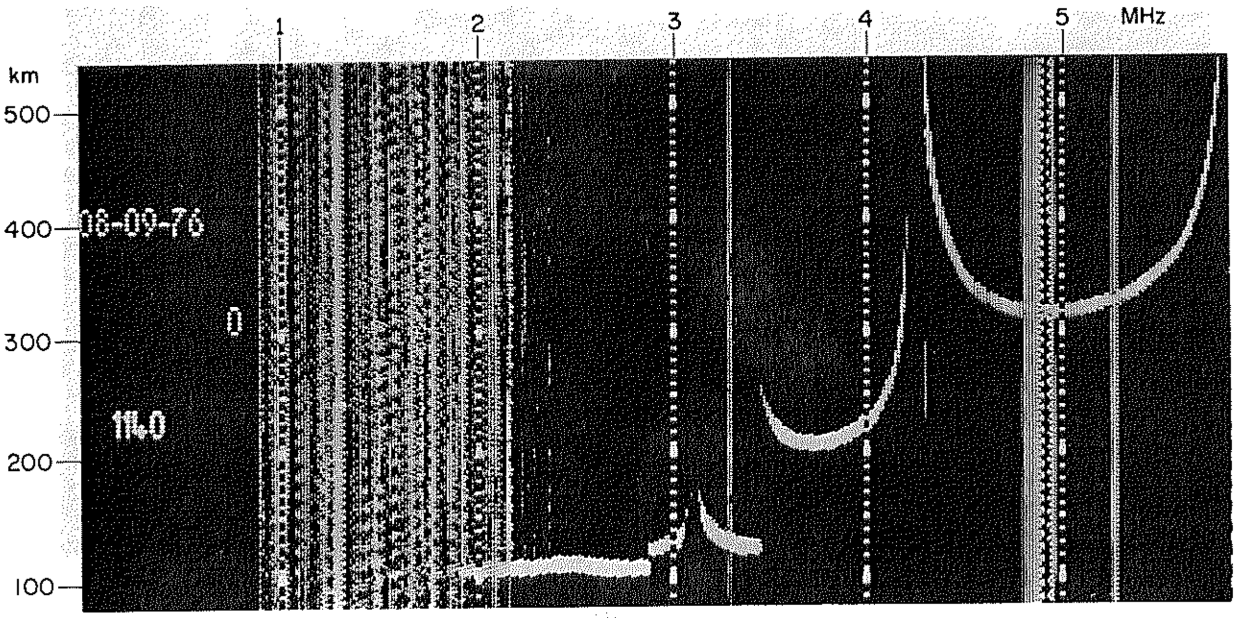

Figure 1. 08.09.76, 1140

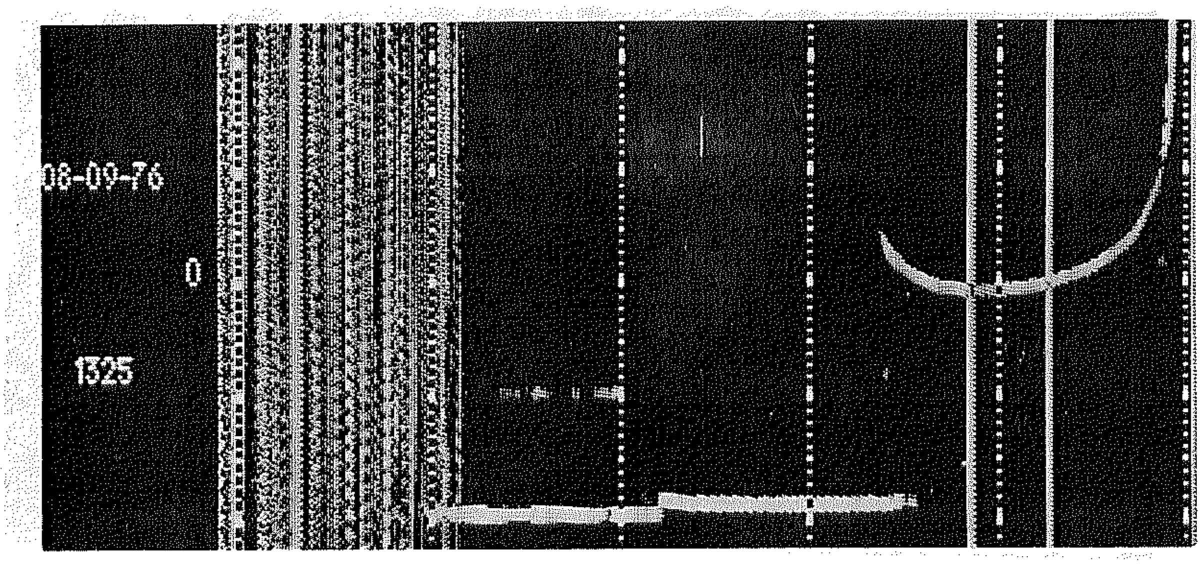

Figure 2. 08.09.76, 1325

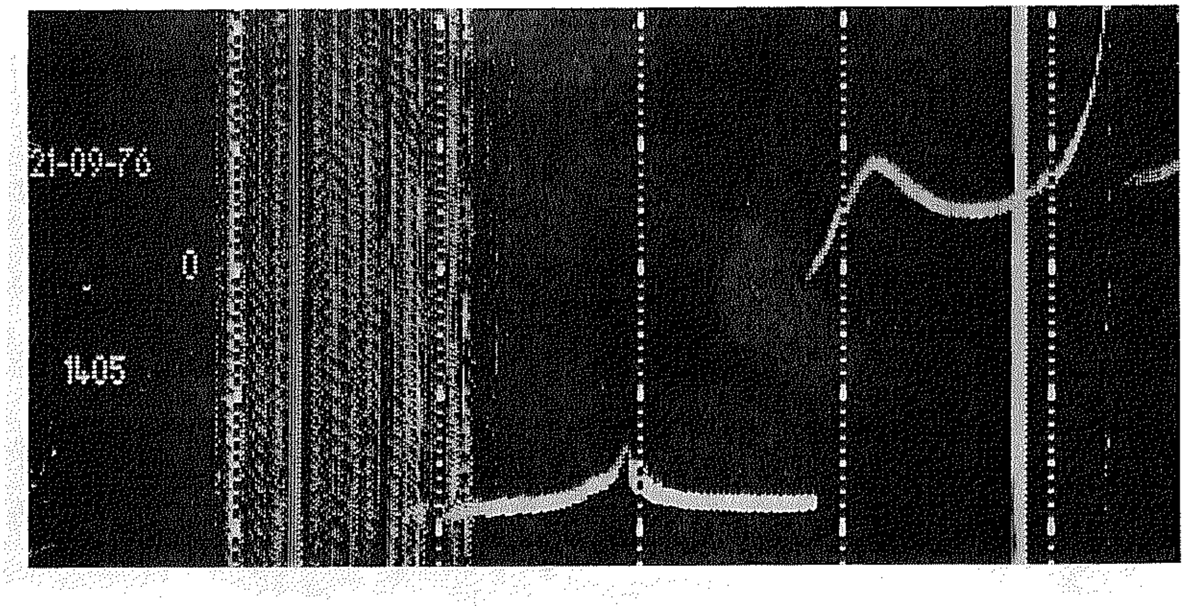

Figure 3. 21.09.76, 1405

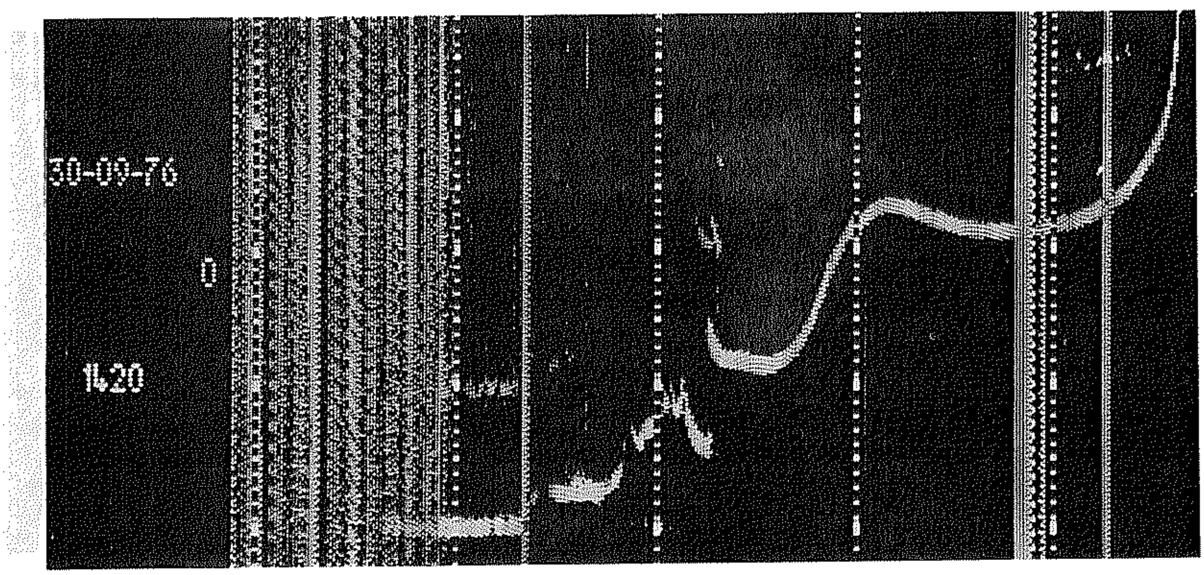

Figure 4. 30.09.76, 1420

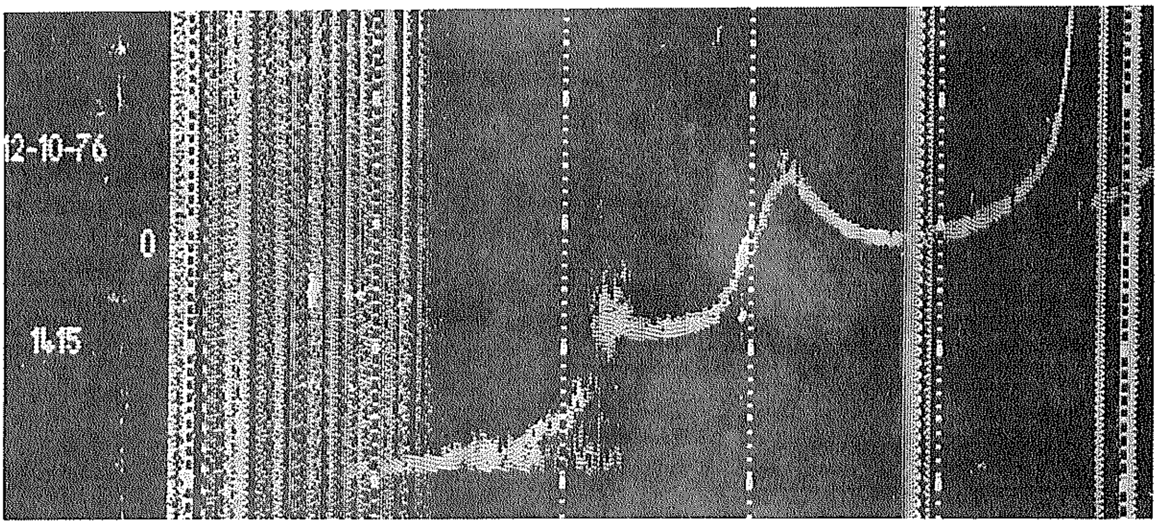

Figure 5. 12.10.76, 1139

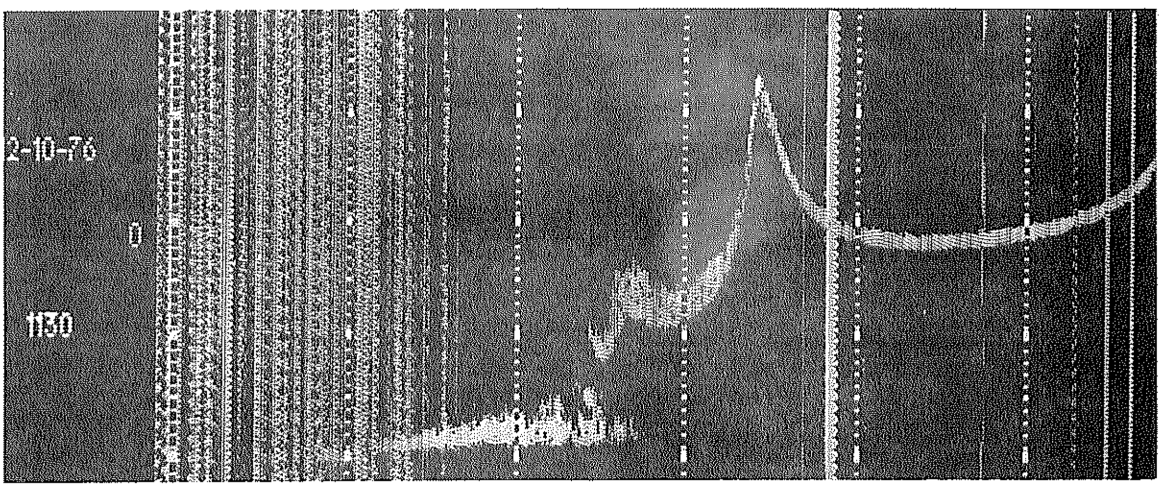

Figure 6. 12.10.76, 1415

XIV. Es-d Traces at South Georgia, Argentine Islands and Halley Bay

A. S. Rodger and D. H. Boteler
British Antarctic Survey

Since 1973, there has been a significant increase in the occurrence of echoes with virtual heights below 95 km at South Georgia (54°S, 36°W), Argentine Islands (65°S, 64°W), and Halley Bay (76°S, 27°W). These echoes, examples of which are given in Figure 1, are usually weak and intermittent, consequently, similar in appearance to Es type d (UAG-23, p. 110). However, the occurrence of these traces is not associated with increased magnetic activity, above average value of fmin, or at Halley Bay, increased absorption as measured by riometer. Therefore, this phenomenon is not the classical Es type-d associated with magnetic storms but has properties which are consistent with a gradient reflection. For an introduction to the theory and some observational results on gradient reflections, see Gardner and Pawsey (1953).

These reflections have been scaled in the same way as Es-d, in that they have not been used to determine any Es parameters but have been classified as Es-d under Es types. Although they are observed only during winter months from April to September at all three stations, their diurnal and seasonal variations in occurrence differ significantly as shown in Table 1.

Conventional storm type Es-d which is comparatively rare at Halley Bay at sunspot minimum is virtually unknown at South Georgia and Argentine Islands; classifying these traces as Es-d should not, therefore, lead to confusion. For this reason, we intend to continue our present scaling practice in order to establish the detailed morphology of this phenomenon.

Table 1.

The Diurnal and Seasonal Variations of "Es-d"

Observatory	Diurnal Variation	Seasonal Variation
South Georgia	Maximum about local noon but restricted to period when normal E would be expected.	Single maximum in June/July
Argentine Islands	Same as for So. Georgia	Two maxima in April/May and July/August
Halley Bay	No significant variation.	Same as for So. Georgia

Reference

Gardner, F. F., and Pawsey, J. L., 1953. J. Atmos. Terr. Phys. 3, p. 321.

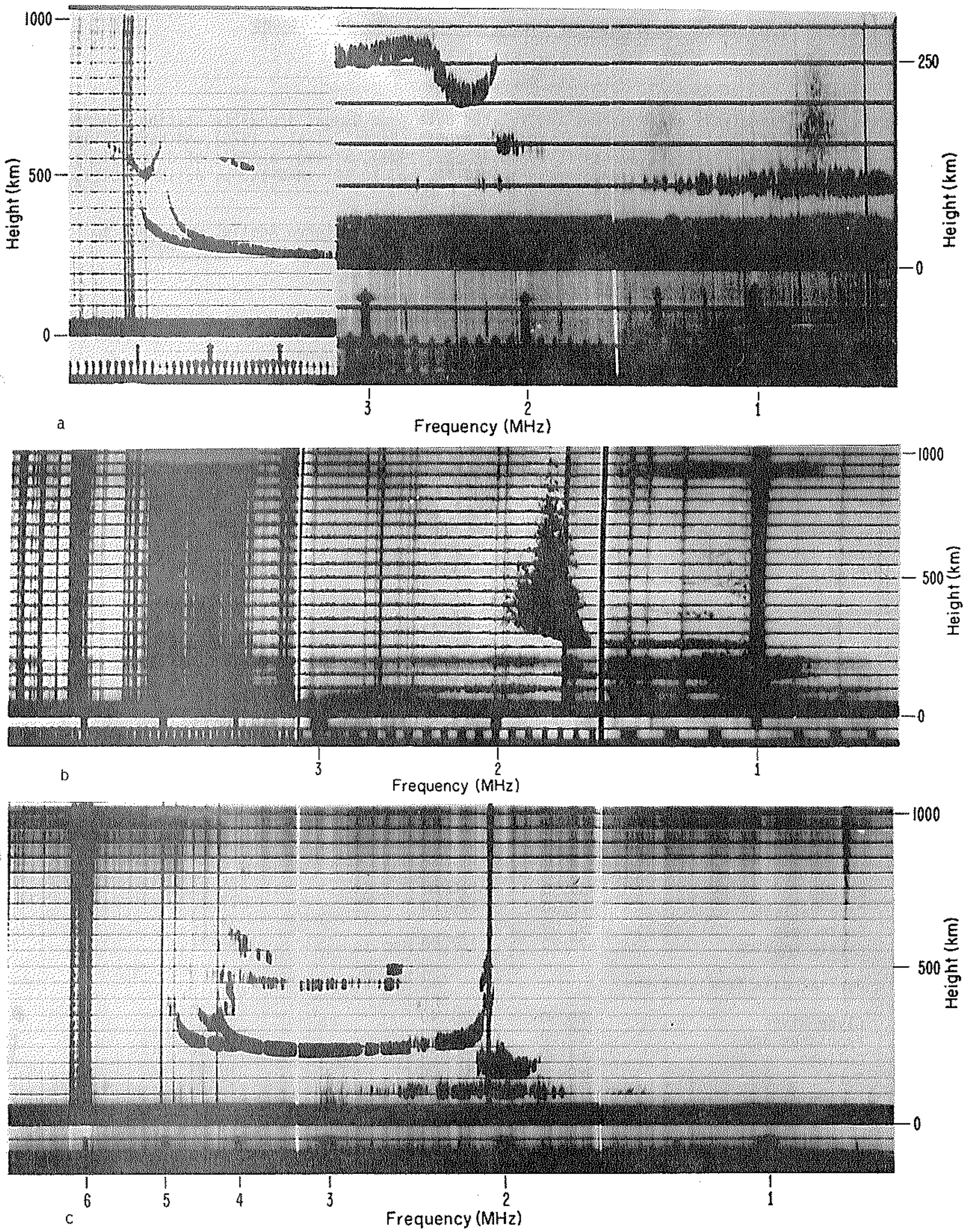

Figure 1. (a) South Georgia, 26 July 1975, 1430 LMT 30°W; (b) Halley Bay, 1 July 1975, 0945 LMT 30°W; (c) Argentine Islands, 6 August 1976, 1345 LMT, 60°W.

XV. Occurrence of Lacuna at High Latitude Stations

M. Silvain
St. Maur, France

Several years of analysis of ionograms and related data from Dumont d'Urville station (Terre Adelie) led us to a classification of the observed absorption events (Vassal et al., 1976) and have allowed us to describe more precisely F-lacuna events (Sylvain et al., 1978), already a topic of discussions among INAG people. (INAG-9, pp. 5-10, full description; INAG-12, pp. 10-19; INAG-14, p. 6; INAG-18-19, p. 7; High Latitude Supplement, pp. 15, 87, 164, 228-238.

As we now know fairly well the morphology of F-lacuna events in Terre Adelie, we wished to answer the following questions:

- where does the phenomenon occur?
- does it look everywhere the same?
- do its statistical properties change from one place to another?
- does it occur simultaneously everywhere or not?

To answer these questions we needed data for the same selected period from as many stations as possible.

The most favorable period giving the maximum number of high-latitude operating stations appeared to be the IGY, and we selected accordingly, May-July 1958 for northern stations, and December 1957 - January 1958 for southern ones.

The best method to detect lacuna is direct inspection of the ionograms particularly as no scaling rule concerning lacuna existed at the time of IGY. Mrs. Cartron and I, therefore, spent the month of June 1976 at the World Data Center in Boulder where we could look at thousands of ionograms.

F-lacuna, morphologically identical to that seen at Dumont d'Urville, were apparent on ionograms from the following stations and were scaled systematically.

Station	Geographic Position		Invariant Latitude
	Latitude	Longitude (east)	
Eureka	80.0	274.10	89.00
Alert	82.6	297.40	86.74
Thule	76.40	291.30	85.60
Resolute Bay	74.7	265.10	84.00
Godhavn	69.3	306.50	76.9
Baker Lake	64.3	264.00	74.7
Churchill	58.8	265.80	69.8
Point Barrow	71.30	203.20	69.3
Wilkes	-66.90	110.50	80.57
Cape Hallett	-72.30	170.20	77.2
South Pole	-90.00	-	74.19
Little America	-78.20	197.80	73.51
Partial data from stations:			
Clyde River	70.50	291.40	80.70
Frobisher Bay	63.80	291.40	74.81
College	64.90	212.20	64.56
Byrd	-80	240.00	67.94
Ellsworth	-77.72	318.90	61.80

The stations where ionograms exhibit F lacuna show that it is a common phenomenon in the high-latitude ionosphere. At all stations, as in Terre Adelie, we found the three types of lacuna described in INAG-9, pp. 5-10.

At all stations, as in Terre Adelie, the type of lacuna may change from one ionogram to the next (one-quarter hour later). The preparation of the data in a form suitable for computer processing took longer than we expected and we have only just begun to study them scientifically.

We first looked for the statistical properties of occurrence at all stations. The shape of the histograms varies from one station to another. In particular, the histogram with two maxima of occurrence typical of F2 lacuna at Dumont d'Urville is found only at Godhavn, Point Barrow, Cape Hallett and Little America.

Lacuna is easily seen to occur on the same days at different stations. This point has been quantitatively established by a correlation study. .

We are at present working with more details on some particular events and it is expected that the results will soon be ready for publication.

I would not end without recalling the hospitality and help we were given by the staff of WDC-A and thanking them sincerely for it.

INAG Questionnaire on the Future Operation of the V.I. Network

Please fill in the sections on which you have views and return to:

Mr. W. R. Piggott
Chairman of INAG
British Antarctic Survey
Madingley Road
Cambridge CB3 OET
United Kingdom

INAG wishes to discuss the future of the V.I. network at the General Assembly of URSI, August 1-10, 1978, and, for this purpose, needs to know whether the producers and users of the data wish the current procedures to continue in the 1980s, or feel that they should be reviewed. The Report of the Joint IAGA/URSI Working Group on these problems: "Needs for Ionosondes in the 1980s" was published in INAG-26, pp. 7-14. This recommends that an important network be maintained, and suggests criteria for deciding which stations are most needed. Points from letters will be reported in the INAG Bulletins.

Future of V.I. Network

1. At the present time at your stations;

(a) Do you expect the stations below to continue operation in the 1980s?

(b) Are you expecting them to close at the end of the IMS?

(c) Not known

Station	(a)	(b)	(c)

2. If suitable ionosondes become available, might you be interested in opening a station at a new site, or reopening one at an old site?

If YES, please indicate possible sites.

YES	NO

3. Should the analysis procedures be simplified after the IMS? (Note this implies that post- and pre-IMS data will not be compatible.)

	YES	NO
If so, by reducing list of parameters to be measured?		
If so, by simplifying Handbook rules on interpretation?		
If so, by simplifying or omitting some letter symbols?		

4. Should any new parameters be adopted in place of an existing parameter?

YES	NO

If YES, list new parameter and if possible, proposals for existing parameter to be omitted. (Note: INAG cannot increase the workload at stations, some stations want it reduced if possible.)

5. Parameters to be Circulated

The international recommendations on parameters to be circulated represent a compromise between work involved and usefulness of data. In recent years they were increased by adding fxI. INAG needs to know whether you find the current list satisfactory or, if not, which parameters you would like to see made optional.

Present list satisfactory?

YES	NO

In the list below please tick in:

(1) For parameters you feel must be circulated.
(2) For parameters you feel the value of the data does not justify the work needed.
(3) For parameters you feel probably justify the work involved.
(4) No opinion.

	fxI	foF2	foF1	foE	foEs	fbEs	fmin
1							
2							
3							
4							

	M(3000)F2 or MUF3000 F2	M(3000)F1 or MUF3000 F1	h'F2	h'F	h'Es	h'E	Es types
1							
2							
3							
4							

In reviewing the parameters to be circulated in the 1980s, the INAG meeting at Geneva felt that definite views should be requested on the following to guide discussion at Helsinki:

	YES	NO
(i) Es Types		
Should the scaling of Es types be made optional:		
(a) at high latitudes.		
(b) at temperate latitudes		
(c) at low latitudes.		
Should Es types be simplified:		
If YES, should the following be combined:		
(a) h and c		

	YES	NO
(b) h, c and f		
(c) h, c, ℓ and f to give a temperate latitude Es class		
(d) k and r		
(e) a, k and r		
(f) a, k, r and storm-associated f, to show any type of of Es due to particle activity.		
(ii) Should any new rules be made to simplify analysis of Es, e.g., should Es low be ignored unless fbEs exceeds foE for the trace?		
(iii) Should the numerical Es parameters be reduced in number?		
If YES, prefer fbEs		
prefer foEs		
prefer fxEs		
prefer fEs (ignoring whether o or x mode)		
Is h'Es worthwhile		

(iv) fxI

The value of fxI is being reviewed by CCIR and INAG. Pending the results of this analysis, INAG would like to know whether you find scaling fxI more or less difficult than scaling foF2. (Note: Spread-F typing should be ignored in this statement.)

More	Less	Roughly Equal

(v) Spread-F typing (optional parameter)

	YES	NO
Do you attempt spread-F typing at your station		
Do you think spread-F typing is useful?		

INAG is intending to carry out some tests on the usefulness of spread-F typing data using those stations which have recorded it.

6. Letter Symbols

(i) Note: A full list of letter symbols must be available so that there is guidance on how to analyze with the greatest accuracy, particularly where special phenomena occur. However, the work at many stations could be made simpler by making the use of certain symbols optional and permitting others to be used in place of them. In order to see whether there is enough demand for such simplification to justify a full discussion of each possibility, INAG wishes to know your present views. If sufficient demand exists, it will then set out the pros and cons of any proposals so as to form a consensus of opinion.

(ii) Essential Letter Symbols

At present there appears to be a general view that the following symbols are essential. If you feel that the rules for using them should be simplified, please put X after the symbol; if you feel the rules should be kept as at present, put ✓ ; if no view, leave blank.

A B C D E R G J L S U

(iii) Possibly Optional Letter Symbols

Should any of the following symbols be made optional? If YES, put X; if no, put ✓; if no view, leave blank.

H I K M N O P Q R T V W X Y Z

(iv) Regional Use

Do you feel that certain letter symbols should be recommended for use only in certain regions?

YES	NO

If so, which?

(a) At high latitudes	
(b) At temperate latitudes	
(c) At low latitudes	

(v) Other Changes

Do you want to suggest other changes?

YES	NO

State changes desired: